December 30, 2003

Nahid Zoueshtiagh
Environmental Engineer
Air Division (Air-3)
Region IX
Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105-3901

Subject: Prevention of Significant Deterioration (PSD) Permit Application, Cabrillo Deepwater Port Project

Dear Ms. Zoueshtiagh:

BHP Billiton LNG International Inc. (BHBP) is submitting the enclosed application for our proposed Cabrillo Deepwater Port, a Floating, Storage, and Re-gasification Unit (FSRU) off the coast of Ventura County in Southern California. This deepwater port would be the receiving point for shipments of Liquefied Natural Gas (LNG) from carrier ships that routinely cross the world's oceans and deliver to LNG facilities in North America, Asia and Europe. On Cabrillo Port the LNG would be restored to natural gas via the re-gasification process, which warms it to a point where it becomes natural gas, for delivery into the existing natural gas pipelines of the Southern California Gas Company. An application for a deepwater port license has also been submitted to the U.S Coast Guard on September 3, 2003 and is pending review.

The FSRU will be permanently moored 14 miles offshore of Ventura County, well outside existing shipping lanes and 15 miles from the Channel Islands National Marine Sanctuary. The FSRU is a floating vessel similar in shape and design to an ocean-going ship, measuring 938 feet by 213 feet. It will house three spherical storage tanks into which the LNG will be pumped from delivering carriers. These tanks can store over 41,000 tons of liquid. Eight vaporizers on the vessel will regasify the LNG for delivery through subsea pipelines into an existing natural gas interconnection onshore.

Please note that certain portions of this application have been deemed *Confidential-Sensitive* and have been labeled as such.

Should you have any questions concerning this PSD permit application submittal, you can contact me at (805) 604-2795.

Sincerely yours,

BHP Billiton LNG International Inc.

Steven R. Meheen
Project Manager

Enclosure: PSD Permit Application Package

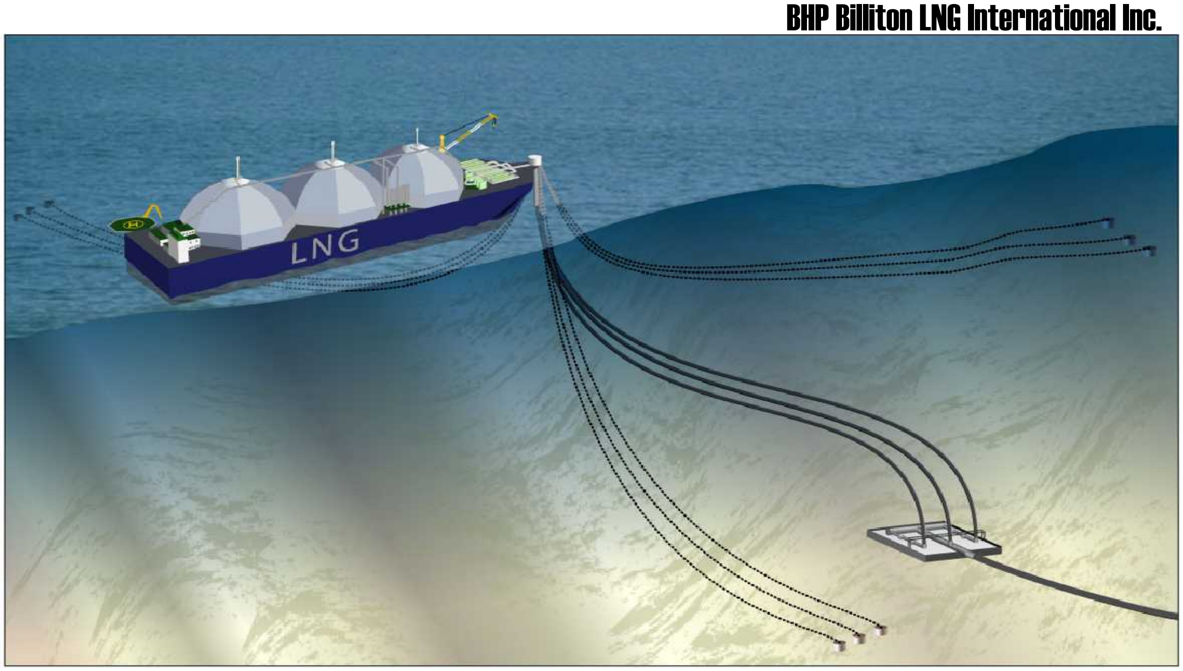
PREVENTION OF SIGNIFICANT DETERIORATION (PSD) PERMIT APPLICATION

Cabrillo Port

Deepwater Port in the Vicinity of Ventura, California

Submitted to:
United States Environmental Protection Agency
Region IX – Air Division

Submitted by:
BHP Billiton LNG International Inc.



December 2003

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ABBREVIATIONS AND ACRONYMS

AHTS	anchor handling tug supply
API	American Petroleum Institute
BACT	best available control technology
barg	line pressure unit
bbl	barrels
bbl/day	barrel per day
Bcf	billion cubic feet
Bcf/d	billion cubic feet per day
BHP	brake horsepower
BHPB	BHP Billiton
BMPs	best management practices
BOD	Biological Oxygen Demand
BOG	boil-off gas
Btu	British thermal unit
Btu/ft^3	British thermal units per cubic foot
Btu/ft^2-hr	British thermal units per feet squared hour
ºC	degrees Celsius
CAA	Clean Air Act
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CP	corrosion protection
CPUC	California Public Utilities Commission
CSLC	California State Lands Commission
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DWPA	Deepwater Port Act
Dwt	dead weight tons
EA	Environmental Analysis
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ESA	Endangered Species Act

ESD	emergency shutdown
°F	degrees Fahrenheit
Fps	feet per second
FSRU	floating storage and regasification unit
ft	feet
GBS	gravity based structure
GHG	Greenhouse Gas
gm/m	grams per meter
Gpm	gallons per minute
GPS	Global Positioning System
HAPs	Hazardous Air Pollutants
Hp	horsepower
kg/h	kilograms per hour
kg/s	kilograms per second
kW	kilowatt
kV	kilovolt
Lb	pound
lb/h	pounds per hour
LP	low pressure
LPG	Liquefied petroleum gas
LP/HP	low pressure/high pressure
LNG	liquefied natural gas
m/s	meters per second
m^3	cubic meters
m^3/h	cubic meters per hour
MAOP	maximum allowable operating pressure
$\mu g/m^3$	micrograms per cubic meter
mg/l	milligrams per liter
MMBtu	million British thermal units
MMBtu/hr	million British thermal units per hour
MMCF	million cubic feet
Mmgal	million gallons
MMS	Minerals Management Service
MW	Megawatts
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants

NFPA	National Fire Protection Association
NM	nautical miles
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NSPS	New Source Performance Standards
NSR	New Source Review
O_3	Ozone
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
P&Ids	process and instrumentation diagrams
$PM_{2.5}$	Particulate matter (2.5 microns in diameter)
PM_{10}	particulate matter (10 microns in diameter)
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
psig	per square inch, gauge internal pressure
SCR	selective catalytic reduction
SCV	submerged combustion vaporizer
SDV	safety shutdown valve
SO_2	sulfur dioxide
SoCalGas	Southern California Gas Company
T	metric ton
Tph	tons per hour
Tpy	tons per year
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet light
VOC	volatile organic compounds

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

This application package is being submitted by BHP Billiton LNG International Inc. to EPA Region IX for a Prevention of Significant Deterioration (PSD) review of the proposed major new source described below. This application provides information sufficient to enable EPA to determine that the proposed major new source (1) will not cause any violation of the National Ambient Air Quality Standards, (2) will not cause any violation of any applicable PSD ambient air quality increment, and (3) will meet control technology requirements and emission limits representative of the best available control technology. This application also provides an analysis of the source's impact on soils, vegetation, and visibility.

BHP Billiton LNG International Inc. (BHPB) is proposing to construct Cabrillo Port, a new offshore liquefied natural gas (LNG) importation terminal in the vicinity of Ormond Beach, California. The facility consists of a floating storage and regasification unit (FSRU) connected to a new subsea pipeline that ties-in to existing onshore natural gas transmission systems operated by Southern California Gas Company (SoCalGas). The Cabrillo Port will be referred to as the Project in the remainder of this application. The FSRU is a ship-shaped, double-sided, double-bottom LNG storage and regasification vessel that will be 286 meters long and 65 meters wide, and will displace approximately 190,000 dead weight metric tons (DWT). DWT is a nautical term used to describe the amount of cargo, fuels, water, stores, and crew that a vessel can carry when fully loaded.

The FSRU will be moored to the seabed by a fixed, turret-style mooring point. The Project also includes a single new 30-inch-diameter subsea pipeline transiting from the FSRU to an onshore metering and custody transfer point, and connecting the Project to the existing gas transmission system of SoCalGas. Figure 1.1-1 illustrates these components of the Project. The FSRU and its mooring point will be located 13.9 statute miles offshore in waters about 2,900 feet deep. The pipeline will make landfall at Ormond Beach north of the existing Ormond Beach power generating station, where the Project pipelines will connect with the SoCalGas system. The landfall will be at an existing SoCalGas facility.

The FSRU will receive shipments of LNG from natural gas fields in the Pacific Basin. The LNG will be converted to natural gas on board. The FSRU can regasify up to a maximum capacity of 1.5 billion cubic feet (Bcf)/day, with a normal rate between 0.6

Bcf/day and 0.9 Bcf/day. FSRU operations are anticipated to commence in calendar year 2008.

1.2 FACILITY LOCATION

The FSRU will be moored offshore of Leo Carrillo State Beach, 14.04 miles offshore and 21 miles south of Anacapa Island. The exact latitude and longitude location of the project is as follows: Latitude: 33 51.518 N; Longitude: 119 02.015 W. This location is 18 miles from the Channel Islands National Marine Sanctuary, and well away from all shipping and small vessel traffic lanes, missile testing ranges, and zones of naval activity. It is also located far enough offshore to be almost below the horizon from many viewpoints.

The onshore portion of the Project extends inland 0.4 miles and passes beneath Ormond Beach. The pipeline will daylight in an existing SoCalGas facility (adjacent to Reliant Ormond Beach Generating Station).

The offshore portion of the Project is located in the Southern California Bight (SCB), an ecologically distinct marine ecosystem spanning 260 miles from Point Arguello to Mexico. The SCB is defined by an abrupt change in the orientation of the California Coastline to a northwest-southeast direction in the vicinity of Point Conception. Ocean circulation in the SCB and in the vicinity of the Project is primarily influenced by the California Inshore Countercurrent, which flows adjacent to the shoreline in a northwesterly direction. Local surface circulation is also strongly influenced by local bottom topography, landmasses, offshore current motion, and local weather. The orientation of the SCB and the presence of the Channel Islands significantly reduce wave and wind action in the Project area. A general location of the Project is shown in Figure 1.2-1.

1.3 PROJECT EMISSION SOURCES

The primary air pollution sources on the Terminal will consist of eight submerged combustion vaporizers (SCVs) and three natural gas fired generator engines, which will generate electricity to supply the power requirements of the Terminal.

Additional sources of regulated air pollutants will be diesel-powered equipment, including emergency backup generators, emergency firewater pumps, and a freefall emergency lifeboat.

The air emissions sources associated with the Project are included in Tables 1.3-1 and 1.3-2 below. Section 3.0 discusses emission sources, estimated emissions, and emission calculations in more detail.

Table 1.3-1. Stationary Sources

Quantity	Description	Rating (each)	Fuel
3	Main Generators	7400 KW (9924 BHP)	Natural Gas
1	Dual-Fueled Backup Generator	6000 KW (8046 BHP)	Gas / CA Diesel
8	Submerged Combustion Vaporizers	39.75 mmBTU/hr	Natural Gas
1	Emergency Firewater Pump	800 BHP	CA Diesel
1	Emergency Generator	4200 KW (5632 BHP)	CA Diesel
1	Diesel Fuel Storage Tank	30,000 gallons	CA Diesel
2	Freefall Lifeboats	75 BHP	CA Diesel

Table 1.3-2. Mobile Sources

Quantity	Description	Rating (each)	Fuel
1	LNG Carrier	45,600 BHP	Gas
2	Assist tugs	9250 BHP	CA Diesel
1	Crewboat	875 BHP	CA Diesel
1	Supply boat	3250 BHP	CA Diesel

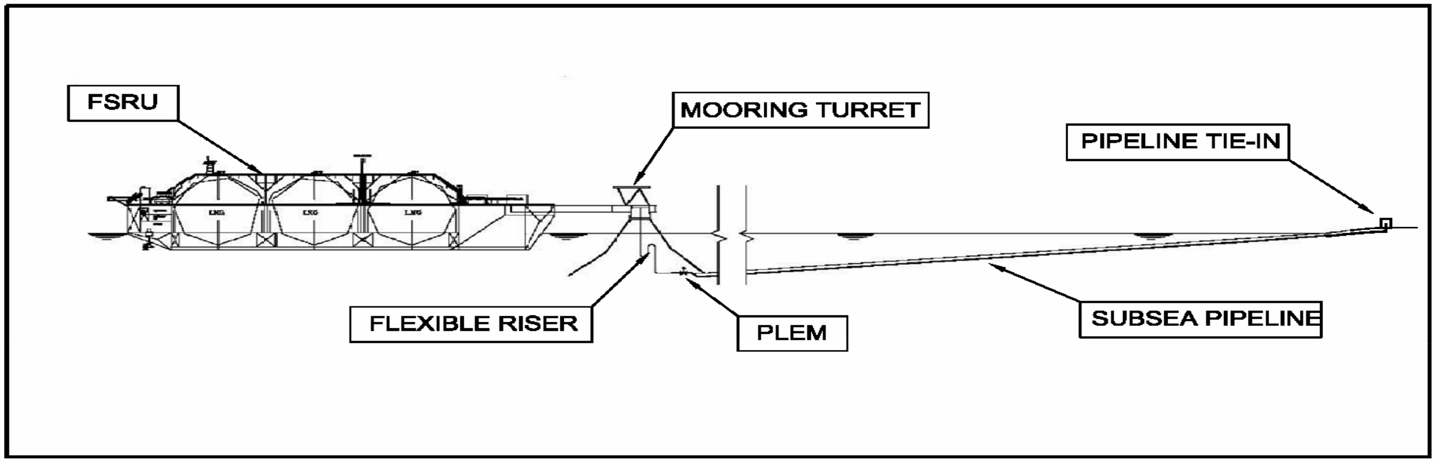
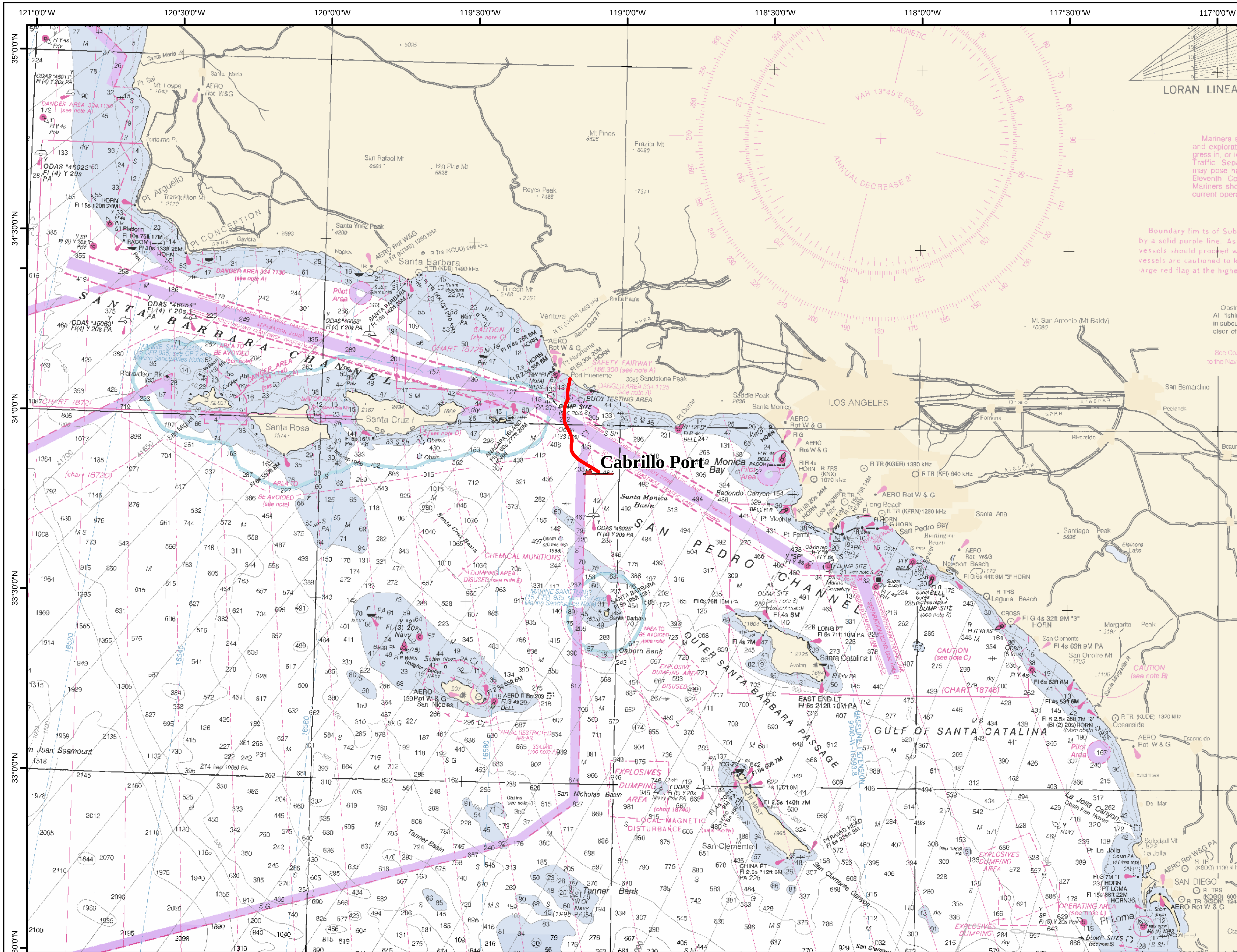


Figure 1.1-1 Profile of Facilities

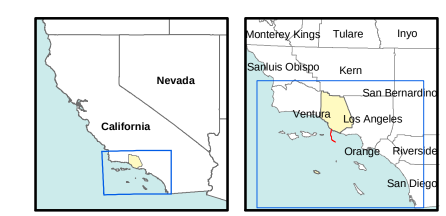


Cabrillo Port Pipeline Route

Cabrillo Port Mooring Point

448 Sounding (Fathoms)

Source: NOAA San Diego to SF Bay 1:868,000 Nautical Chart



1:1,140,000

10 5 0 10 20 Miles

NAD27 UTM Zone 11

Figure 1.2-1
Southern California Coastal Region

Cabrillo Port
Offshore LNG Import Terminal

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2.0 PROJECT DESCRIPTION

2.1 PROCESS FACILITIES

All activities that are in direct contact with carrier-supplied product (liquids and gases) are considered part of the process. The process consists of offloading the LNG from ocean-going vessels to storage tanks, lifting the LNG from storage tanks, pumping the cold liquid to pipeline pressure, subsequent vaporization across heat exchange equipment and finally sendout through custody transfer metering to the SoCalGas pipeline network. Process flow diagrams of the Cabrillo Port operational processes are included in Appendix C. Details of each major component of the process are provided below.

2.1.1 LNG Receiving

The LNG receiving system includes LNG carrier mooring systems, loading arms and shutdown systems. LNG carriers will deliver LNG to the FSRU. Figure 2.1-1 contains a plan view of the FSRU with a moored LNG carrier alongside. The proposed mooring arrangement has been designed based on experience from similar operations. Hydrodynamic analyses were performed to calculate relative motion at the location of the loading arm, tension in the mooring lines, and forces in the fenders. The mooring line arrangement as illustrated in Figure 2.1-1 is based on these analyses.

Floating fenders will be deployed along the side of the FSRU to prevent bumping by the LNG carrier during the berthing and LNG transfer. Fenders are bumper-type devices that maintain safe spacing between adjacent ships. Detailed site-specific simulation of docking conditions will determine final fender type and redundancy requirements. Redundancy is designed into all critical FSRU systems, allowing uninterrupted operation when equipment is out of service for maintenance, inspection, or repair. Redundant fenders provide for adequate protection between the FSRU and the LNG carrier in the event of loss of one or more of the fenders. Current fender designs include nine Balmoral Type 30/40, or equivalent, foam filled floating fenders on either side of the FSRU. The fenders will be grouped; including three pairs strategically located along the ship side, a single fender in the forward position, and a single fender at both the forward and aft positions. The paired fender configuration is for safety purposes, as it allows a fender to be accidentally damaged without significant consequences. The specific fender plan may change as design progresses but will maintain these concepts.

The FSRU will be equipped with electric-powered loading arms on the starboard side; loading arms may also be added to the port side. The starboard side will have four arms; the port side will have space for the addition of three loading arms. All seven loading arms will be identical 16-inch-diameter marine loading arms. The loading arms will be located approximately midway along the FSRU length. On the starboard side, three of the four loading arms will be for the receipt of LNG. The fourth arm will be for return flow of natural gas vapor displaced from the FSRU. On the port side, two loading arms could be added and used for LNG receipt, and one could be added and used for return of natural gas vapors. To accommodate movement between the LNG carrier and the FSRU during LNG transfers, the arms have the following allowable range of motion:

- Longitudinal: ± 3 meters (10 feet),
- Vertical: ± 3 to 4.5 meters (10 to 15 feet), and
- Lateral: ± 3 to 4 meters (10 to 13 feet).

The loading arms are designed with redundant valves and emergency shutdown (ESD) systems.

The total LNG transfer rate, through the starboard side loading arms, will be approximately 80,000 gallons per minute (gpm), equivalent to 2,740 tons per hour (tph). Each LNG carrier berthing, unloading, and de-berthing event will last approximately 20 hours and will occur approximately three times per week.

The storage and handling of a cryogenic material such as LNG requires extensive safety systems to ensure operational efficiency. Tank overflows are unlikely due to the integrated safety and control systems in the LNG tanks.

2.1.2 LNG Storage

The FSRU will store LNG in three Moss-type spherical tanks. This tank design is the most widely used in marine LNG transport because of its simplicity, relative ease of design and robust characteristics. The tanks will be designed and built in accordance with the International Maritime Organization (IMO) International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, also known as the International Gas Carrier (IGC) Code of 1993. This code generally is referred to as IMO IGC Code 1993. Each Moss tank will have a 56-meter diameter and a LNG storage capacity of 91,000 m^3. The total FSRU LNG storage capacity will be 273,000 m^3. The internal tank shell will be aluminum, surrounded by layers of insulating material and clad in an external steel shell. Each Moss spherical tank will be supported on a steel skirt ring that is braced inside the double hull of the vessel. Each Moss tank will be located in a separate cargo hold, with the tank skirt mounted directly on the foundation deck.

The spherical design of the Moss tank reduces internal wave forces that can build up and cause damage in non-symmetrical tanks. The design also allows Moss tanks to be used without any filling restrictions for loading and unloading operations on the open seas. Filling restrictions are used when necessary to limit tank inventories to near full or near empty, as internal wave forces are most severe at intermediate fill levels. LNG carriers with other tank designs successfully operate with filling restrictions. Carriers with non-spherical tanks and filling restrictions do not conduct loading or unloading operations on the open seas. Their cargo tanks are near full enroute to a LNG receiving terminal, and are near empty on their return trips after offloading the LNG.

The FSRU operation will involve continuous fill level changes as LNG is received and natural gas is sent out. The dynamics of internal wave forces at various fill volumes have been studied as part of the design of the FSRU storage tanks. The tanks are designed to withstand design internal wave forces and stress from long-term internal wave action.

The entire internal and external shells of Moss-type tanks can be easily inspected and repaired if necessary. Membrane-lined tank systems, in contrast, require significant downtime for access and repair. The normal fatigue-based life expectancy of a Moss tank is about 100 years. A diagram of a typical FSRU LNG storage tank is presented in Figure 2.1-2. The tanks are designed in accordance with Type B tank principles with a “leak-before-failure” philosophy with a 15-day lag designed between when a leak may be detected and when a tank failure would occur. This built-in time buffer allows for a leak to be assessed and for actions to be taken to remedy the situation. For example, LNG in the affected tank could be transferred out to the other tanks, and the affected tank removed from service for repairs.

Although the normal tank operating pressure is approximately atmospheric, the tanks will be designed for up to approximately 30 pounds per square inch, gauge [psig] internal pressure. This design pressure allows the tanks to be operated as a closed system, containing boiled-off natural gas vapors for extended periods. The design pressure also allows the tanks to be emptied using pressure to force out the contents, rather than needing to pump out the contents.

No mechanical means of refrigeration are required. The insulation on the FSRU LNG tanks will be designed to allow a boil-off of 0.12 percent per day under normal ambient conditions. The boiled-off natural gas will be sent out through the natural gas send out line, or recovered and used as fuel for FSRU electric power generation as described in more detail below.

2.1.3 LNG Regasification

The process area on the foredeck portion of the FSRU will include the equipment necessary to regasify the LNG, i.e., converting the LNG back into natural gas. The regasification process will include LNG pumps, LNG booster pumps, and vaporizers. Specifications and other design details for the submerged combustion vaporizers (SCVs) and other regasification plant equipment are included in Appendix B.

The electric-powered LNG pumps will transfer LNG from the Moss tanks to the booster pumps located in the process area. There will be nine in-tank submerged-type LNG pumps, three in each LNG tank. The LNG pumps will have a capacity to transfer up to 13,000 gpm. The number and capacities of the pumps are another example of redundant design. An individual LNG pump will be able to be taken out of service for maintenance without interrupting natural gas send out.

Up to six LNG booster pumps will be located in the process area. These four-stage centrifugal pumps will increase the LNG pressure up to a maximum of approximately 1,500 psig. These booster pumps will discharge directly to the vaporizer inlet manifold.

The vaporization portion of the process will regasify the LNG into natural gas. The process will consist of eight SCVs. However, only a maximum of five of the SCVs will be operating at any one time. Each SCV will be fueled on natural gas, with a maximum heat input of 39.75 mmBTU/hr, and will have a maximum capacity of 198 short tons of LNG vaporized per hour. The SCVs will heat the LNG resulting in natural gas at a temperature of 41 ^{o}F and a pressure of 1,500 psig. No compression of the natural gas will be required. The LNG will be pumped, as liquid, up to the 1,500-psig natural gas send out pressure and maintained at that pressure through the vaporization process.

Combustion of natural gas will provide the SCV process with heat for regasification. The SCV process will be thermally stabilized by submersion in a water bath. The LNG and natural gas flow will be contained within process piping submerged in the water bath. Neither LNG nor natural gas will be directly released into the water bath, but combustion exhaust gas will bubble through the water bath. The water bath will provide stable heat transfer to the LNG, forming natural gas. The water bath will be cooled as the natural gas absorbs heat from it. The normal regasification capacity will be between 579 and 821 short tph, and the maximum regasification capacity will be 1,450 tph. The quality, temperature, and pressure of regasified natural gas will be suitable for send out and delivery into the receiving natural gas transmission system in California.

The process to convert natural gas to LNG removes many impurities normally found in natural gas, such as sulfur compounds, nitrogen, water, oxygen, CO_2, ethane, and heavier hydrocarbons. Table 2.1-1 summarizes LNG compositions that could be delivered to the offshore terminal.

Table 2.1-1. Composition of Natural Gas from LNG

Constituents	Bintulu (Malaysia)	North West Shelf (Australia)	Badack (Indonesia)	Australia Lean Gas
Methane	89.4200	87.8220	90.3600	99.5108
Ethane	5.4000	8.3040	6.1700	0.1130
Propane	3.4200	2.9820	2.5600	0.0113
Isobutane	0.8200	0.4000	0.4500	0.0091
Normal Butane	0.7400	0.4750	0.4300	0.0068
Isopentane	0.0100	0.0000	0.0100	0.0000
Normal Pentane	0.0000	0.0000	0.0000	0.0006
Nitrogen	0.2000	0.0140	0.0200	0.0056
Oxygen	0.000	0.000	0.000	0.000
Carbon Dioxide	0.000	0.000	0.000	0.3428
Total (mol %)	100.0100	99.9970	100.0000	100.0000

2.1.4 Natural Gas Send Out

The process area on the foredeck of the FSRU will include the natural gas send out equipment, including metering equipment. The only compression equipment is for boil-off gas (BOG) management, and involves two sets of compressors. To meet the FSRU operating requirements, the BOG compressor plant requires three compressors, each of capacity 8,000 kilograms per hour (kg/h): one high discharge pressure compressor plus two low discharge pressure compressors.

In practice, due to machine availability, this requirement has been configured as three low pressure (LP) compressors, which boost gas from storage tanks up to fuel gas pressure (4.5 barg), and one high pressure (HP) booster compressor, which boosts gas from fuel gas pressure up to 81 barg.

In normal operation, one LP compressor will operate to compress the BOG into the fuel gas system or reinject into the LNG booster pump suction. The second LP compressor will be required to operate at peak BOG rates during loading. The low pressure/high pressure (LP/HP) compressor combination will normally only operate if the FSRU is shutdown and there is no fuel requirement.

The LP/HP compressor combination will route BOG directly into the natural gas send-out line when there is no use for LP fuel gas (during shutdown). The discharge pressure of the HP BOG compressor is set at 80 barg; this is less than the maximum operating pressure of the pipeline, as pipeline pressure will be reduced when the FSRU is not exporting significant quantities of gas.

By design, the natural gas sent from the FSRU will be metered and will be of a quality, pressure, and temperature to eliminate the need for any subsequent onshore process or compression facilities. The normal gas send out capacity will be 579 to 821 tph. The maximum gas send out capacity with the FSRU as designed will be 11,450 tph.

2.2 TERMINAL OPERATION AND MAINTENANCE

This section describes operation and maintenance procedures for the Cabrillo Port facilities. The emphasis during design, and the continuing emphasis during operation, will be safety. The FSRU and pipelines will be operated and maintained to provide a safe working environment for the life of the facility. Specific operating and maintenance aspects are described below, first for the FSRU and then for the pipelines.

2.2.1 Fuel Gas System, Power Generation, and Utilities

A utility area near the stern of the FSRU, below the crew quarters will include the onboard electric power generation equipment. Three natural gas-fired generator sets and one dual fuel diesel/gas generating set (emergency duty) will generate the onboard electric power. Each of the three primary units will have power output of 7,400 kilowatts (kW) at 6.6 kilovolts (kV), for a total power plant generating capacity of approximately 22 megawatts (MW). The dual fuel unit used for emergency duty will have a power output of 6,000 kW at 6.6 kilovolts.

All the required motor control centers, substations, cabling, and lighting systems will be arranged in accordance with applicable regulations and standards regarding protection, insulation, and general safety. All electrical equipment within gas-dangerous zones will be designed, installed, and supplied with certificates to show that the equipment is intrinsically safe.

A layout of the onboard natural gas distribution system, showing the fuel distribution to the generator sets and SCVs, and other process components, is included in Appendix C, FSRU Design Drawings.

2.2.2 LNG Receipts

Each LNG carrier will approach the FSRU in accordance with strict berthing procedures developed as part of the facility operations manual. After the LNG carrier is securely berthed adjacent to the FSRU, the loading arms will be connected.

2.2.3 LNG Carrier Supply and Waste Transfers

The LNG carrier will be visiting the FSRU in lieu of a land-based terminal. As such, the FSRU becomes the port of call for the LNG carrier and the opportunity for the LNG carrier to re-supply. LNG carrier wastes will not be transferred to the FSRU, nor will the FSRU replenish supplies for the LNG carrier. Re-supply and logistical support for the LNG carrier will be accomplished by supply boat(s) that will attend the LNG carrier during the period in which it is moored to the FSRU, providing supplies and removing waste cargo.

2.2.4 LNG Carrier Ballast Water Transfers

The LNG carriers will come to the FSRU carrying some ballast water. Ballast water will be exchanged outside the 200-nautical mile limit of waters of the United States, and ballast water exchanges will be recorded and reported in accordance with MMS requirements. California also has ballast water regulations, but they are applicable only to ships entering within the 3-nautical mile limit of state waters. The FSRU will be 14.04 miles from shore, so LNG carriers would not be entering state waters to complete LNG deliveries.

2.2.5 Nitrogen and Inert Gas Purging System

Nitrogen will be used when necessary to purge natural gas out of FSRU equipment. This is a safety procedure. The use of nitrogen, or any inert gas, to remove natural gas is a standard industry practice. The process prevents the introduction of air that, when mixed with residual natural gas, could result in a mixture within its flammable limits.

2.2.6 Crew Size and Crew Transfers

The FSRU will carry a normal crew size of 29. Crew will be rotated every 7 days and transferred by boat. These personnel transfers will occur at the aft end of the FSRU, where a transfer platform will be located to facilitate safe transfers.

2.2.7 Helicopter Operations

Although the FSRU is equipped with a helicopter platform, routine helicopter operations are not part of the Project. The helicopter deck will be used for emergencies, such as the removal of a seriously injured crewmember, and periodic helicopter visits by company executives and other official visits. No helicopter fuel will be stored on the FSRU.

2.2.8 Ballast Operations

The FSRU will arrive ballasted for commissioning, and continuous ballast water exchange will take place during normal operations. For the initial arrival of the FSRU from the overseas fabrication port, the FSRU will follow established ballast water exchange protocol, including notification and exchange of ballast water outside the 200-nautical mile limit. During normal operations, the LNG cargo will be constantly shifting as LNG loads are received and natural gas is sent out. To maintain FSRU stability, the LNG inventory changes will be offset by ballast water pumping. Ocean water will be pumped into various ballast tanks, shifted from one tank to another, or discharged back to the ocean. Ballast water will not be chemically treated, and pumps will be screened to prevent fish entrainment.

2.2.9 Natural Gas Odorization

In order to deliver natural gas that is suitable for the existing natural gas transmission system and consistent with DOT safety requirements, the natural gas will be odorized prior to entering SoCalGas facilities. Methane gas, which constitutes a minimum of 85 percent of the natural gas sent out from the FSRU, is odorless. An odorant (typically mercaptan gas) is added so that leaks of natural gas can be detected by its unique sulfur odor. The BHPB odorant injection facility will be located at the onshore pipeline station adjacent to similar odorant stations owned and operated by SoCalGas. The maintenance of an inventory of mercaptan gas on the FSRU is considered a safety hazard and will be avoided by using the onshore injection station.

2.2.10 Diesel Fuel

After receipt of LNG, the FSRU will be fueled by natural gas from the gas send out line or BOG. After LNG operations have begun, the diesel fuel will be retained as an emergency fuel supply. The diesel fuel will be used in monthly tests of the power generator and firewater pumps to ensure their continued operability. The diesel fuel storage tank will be topped off approximately once annually. Diesel fuel will be brought on board in re-useable transportable tote containers; the fuel will be transferred into the FSRU storage tank, and the empty totes then will be transferred back to shore. The diesel fuel storage tank will have a capacity of approximately 88,000 gallons. Diesel fuel will be managed in accordance with EPA and State of California requirements. BHPB will develop and implement a facility-specific Spill Prevention, Control, and Countermeasure Plan (SPCC Plan) as required for DWPA facilities under 40 CFR 112.1(a)(1).

2.2.11 Fuel Gas System

The fuel gas system is supplied by BOG that is compressed up to 4 bar. Additional natural gas from BOG or the send out line will be sent as fuel to the SCVs to provide heat in order to vaporize LNG.

2.2.12 Lubricating Oils

The onboard rotating equipment, including power generation units, BOG compressors, LNG booster pumps, firewater deluge system pumps, and ballast water pumps, will hold an inventory of lubricating oil. Lubricating oil will require periodic change-out. Replacement oil will be brought on board in 210-liter (55-gallon) drums or 1,300-liter (350-gallon) totes. Used oil will be returned to shore in the same containers that are used to provide the replacement oil. Used oil will be managed, disposed of, or recycled in accordance with EPA and State of California requirements. All oil will be managed in accordance with the facility-specific SPCC Plan.

2.2.13 Urea

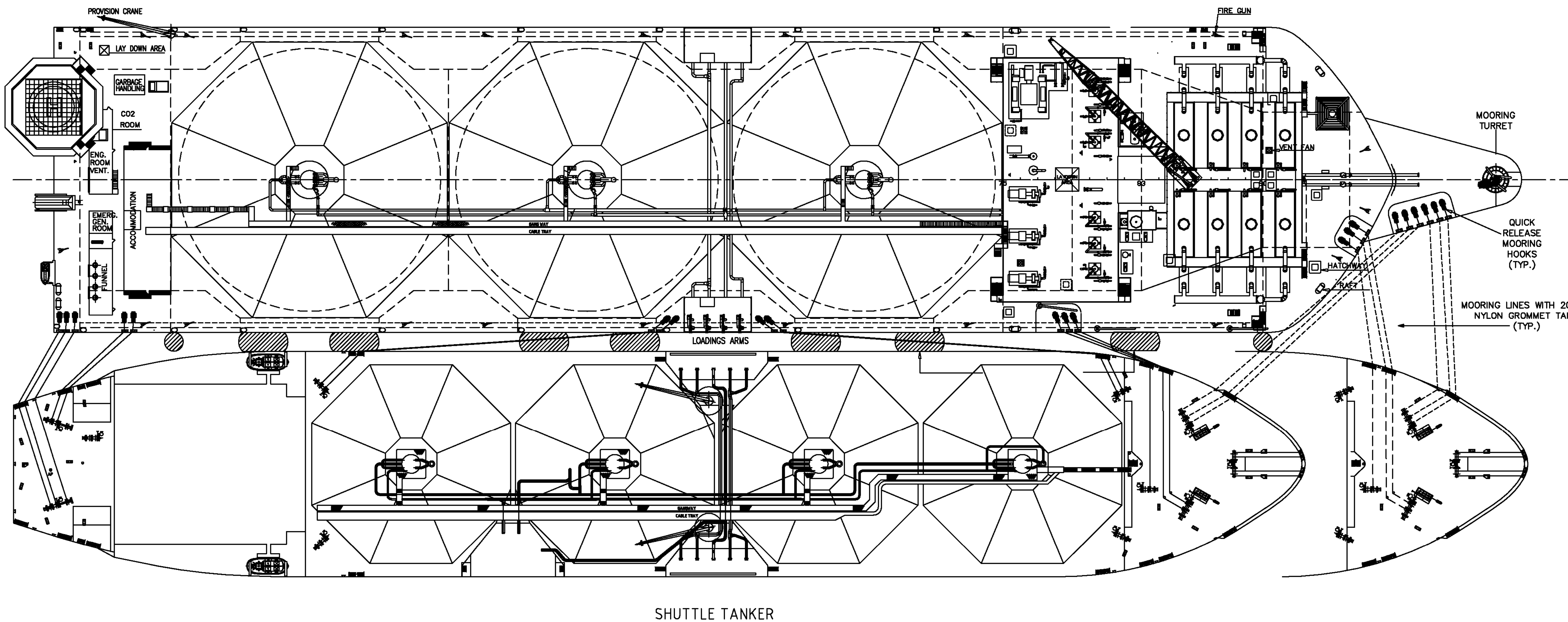
The power generation equipment aboard the FSRU will be equipped with air emissions control equipment designed to reduce the emission of oxides of nitrogen. Selective catalytic reduction (SCR) using ammonia is typical for onshore facilities. Due to safety concerns with ammonia in the offshore environment, the FSRU emissions abatement equipment will instead use urea. Urea can be transported as bagged solid pellets and mixed into an aqueous solution on board.

2.2.14 Potable Water

The condenser portion of the SCV units generates freshwater by condensing moisture out of the air. This water will be collected into the SCV water bath. This system will generate excess freshwater, some of which will be diverted for urea mixing and some for potable water. Bath water diverted for use as potable water will first be treated using ultraviolet light (UV) in a UV oxidation unit, then filtered through a 1 micron filter and finally filtered through an activated charcoal filter (potable water use). This method avoids the need for storing or using chlorine gas or sodium hypochlorite on board the FSRU.

2.2.15 FSRU Supply and Waste Transfers

Incoming supplies and outgoing wastes will be transferred by boat. During normal operations, a supply boat visit will occur once a week. Supplies will range from food, toiletries, and office supplies for crew use in the living quarters to tools, small parts, and other maintenance and repair materials. Solid wastes from the FSRU will be containerized for transfer to the supply vessel. Black water sanitary wastes from the FSRU also will be containerized for transfer to the supply ship. Supply and waste transfers will be made by crane lifts from a supply vessel moored to the aft of the FSRU.


PROVISION CRANE
LAY DOWN AREA
GARBAGE HANDLING
CO2 ROOM
ENG. ROOM VENT.
EMERG. GEN. ROOM
ACCOMMODATION
FUNNEL
FIRE GUN
VENT FAN
MOORING TURRET
QUICK RELEASE MOORING HOOKS (TYP.)
HATCHWAY
RAFT
MOORING LINES WITH 20 m NYLON GROMMET TAILS (TYP.)
LOADINGS ARMS
SHUTTLE TANKER

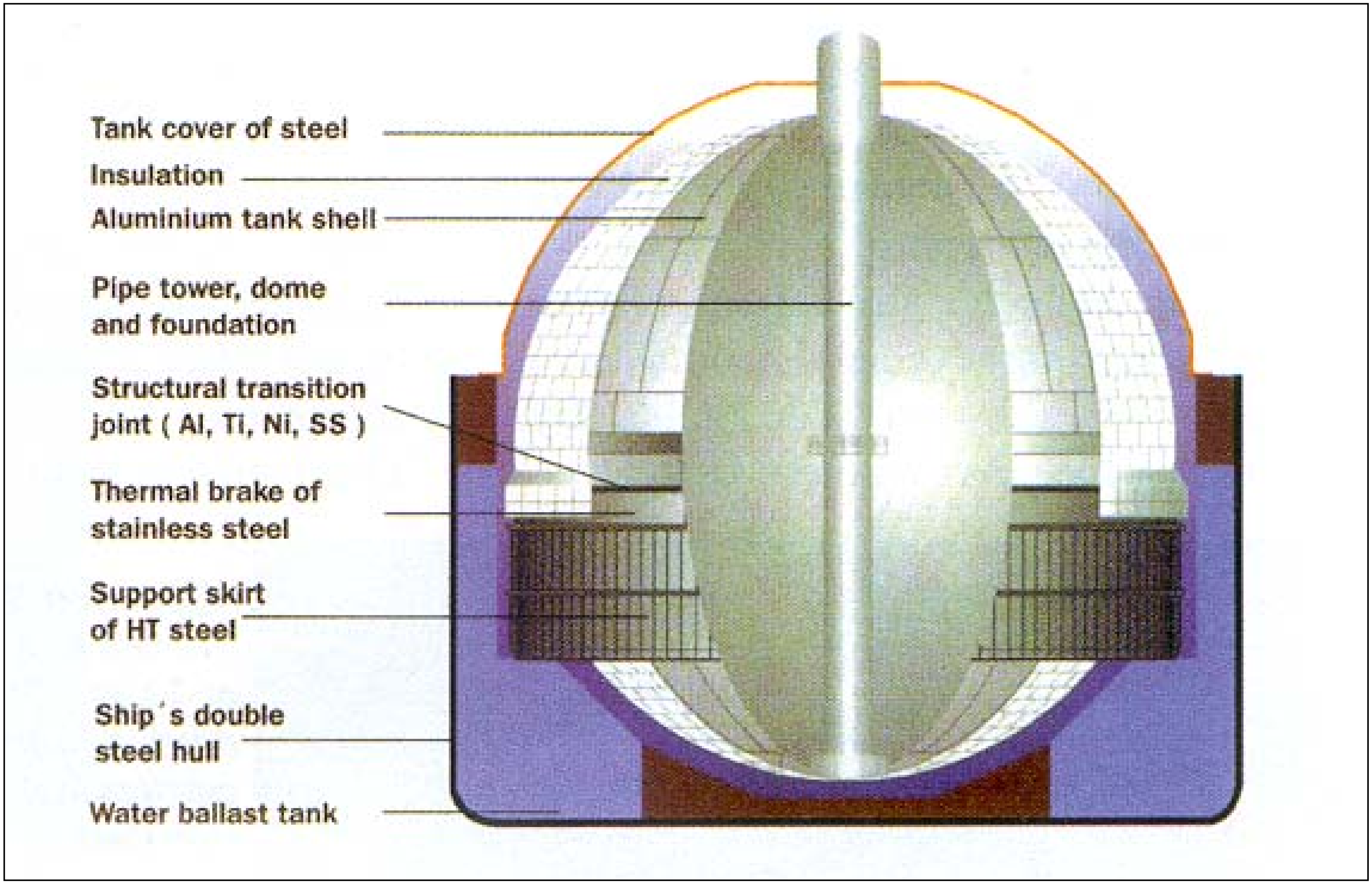


Figure 2.1-2 Moss Storage Tank Cross Section
PSD Application
Cabrillo Port Offshore LNG Import Terminal

3.0 EMISSION CALCULATIONS

This section describes the sources of regulated air emissions for the criteria pollutants and explains how they were calculated, with emission calculation methodologies included in Appendix A.

3.1 CONSTRUCTION EMISSIONS

Emissions of regulated pollutants will be produced during construction of the Project, associated with FSRU mooring, offshore pipeline installation, and onshore pipeline installation (horizontal directional drilling or HDD and trenching of the onshore pipeline). Construction emissions will be generated by the pipelaying barge and other marine vessels and equipment working offshore, drilling, and trenching operations conducted onshore. Emissions during construction activities will occur primarily from fuel combustion in the pipelaying vessel and assist boat engines, as well as the onshore drilling rig and trenching construction equipment. These emissions will consist of NO_x, CO, and small amounts of VOC, PM_{10} and SO_2, along with very small amounts of toxic air contaminants. Since construction does not occur at a single location for any significant length of time, the impact of these emissions at any single location will be minor and short-term. Offshore equipment emissions will be transient due to weather conditions and extremely variable in intensity.

Onshore emissions during the construction phase will consist of exhaust emissions and entrained paved road dust from worker commute trips and material delivery trips to the construction site. Motor vehicle travel associated with the construction activities are anticipated to be minimal, since pipeline lay barges typically house the workers onboard, and thus eliminating daily commuting traffic of the workers. The proposed Project will be staged in an area that is paved. Since minimal site preparation is expected for the landfall (e.g., grading), fugitive PM_{10} emissions from on-site activities will be minimal.

The construction equipment anticipated to be used for the mooring operation includes:

- Two Anchor Handling Tug Supply (AHTS) vessels rated at 12,000 and 15,000 Hp.
- Two supply vessels rated at 4,500 Hp.

The construction equipment anticipated to be used for the offshore pipeline installation includes:

- One 22,721 Hp Dynamic Position Vessel (DPV).
- One small drilling rig with auxiliaries, rated at 400 Hp.

- Four supply vessels rated at 4,500 Hp each.

The construction equipment anticipated to be used for the onshore HDD drilling and trenching operations includes:

- One large drilling rig, with auxiliaries, rated at 2,700 Hp.
- Four cranes, two 100-ton capacity and two 35-ton capacity, for pipe handling and loading.
- Six diesel welding generators.
- One backhoe rated at 100 Hp, and one all terrain forklift rated at 100 Hp.

Mooring installation for the FSRU will occur over a 45-day period. The two AHTS vessel tugs will be utilized to tow the FSRU to its location. Two barges will transport anchors and equipment, and two supply vessels will transport materials and crew. Mooring equipment will be operated about 12 hours per day.

Installation of the offshore pipeline will occur over a 45-day period. The DPV and the small drilling rig will be operated 24 hours per day. Four supply boats will be used 12 hours per day (or two vessels at 24 hours per day).

Installation of the onshore pipeline will also occur over a 45-day period. The HDD rig will be operated 24 hours per day. Two diesel-powered cranes (100-ton capacity), plus two diesel cranes at 35-ton capacity, will be utilized for pipe handling and loading about six hours per day. Ten diesel-welding units will be utilized 0.8 hours per day.

The resulting construction emission estimates and emission rates, along with a complete listing of the construction equipment and estimated operating parameters are summarized in Appendix A.

3.2 OPERATIONAL EMISSIONS

The Project will be located 14.04 miles offshore of Ventura County in an unclassified air quality attainment area, and will be administered by the USEPA Region IX. Operational emissions on the FSRU will exceed the PSD threshold. A detailed discussion of the PSD regulatory requirements for this Project are contained in Section 4.1 of this application.

Air emissions will result from the operation of the gas-powered generator engines used for generating electricity on the terminal and the SCVs. These combustion emissions will consist of NO_x, CO, and small amounts of particulate matter and VOCs. The generators and the SCVs will be the greatest source of NO_x on the terminal, but similar combustion emissions will be emitted from the diesel emergency generators and firewater pump engines. The diesel storage tank will be a minor source of VOC emissions from breathing and working losses. Waste oil tanks and sumps will be a very small source of VOC emissions. The unloading arms will be equipped with a vapor return system so as to avoid VOC emissions during offloading operations. Estimated Project stationary source emissions from the FSRU and estimated emissions from the assist vessels and LNG tankers within the 25-mile radius are shown in Appendix A.

Operation of the Project is anticipated to generate controlled emissions totaling 76 tons of NO_x per year and 24 tons of VOC per year. Emissions of CO are estimated to be about 70 Tpy. The largest portion of CO, NO_x and VOC emissions will come from the SCVs and the power generating engines. The Project will produce about 11 tons of particulates per year, but SO_2 emissions will only equal 0.2 tons. These emissions will largely be due to diesel fuel since the LNG is virtually sulfur-free.

The three lean-burn Wartsila 20V34SG main generator engines will supply the electricity to operate the facility. The Wartsila 20V34SG is a four-stroke lean-burn spark-ignited gas engine. Only two of the three engines will operate up to 100% loading, utilizing BOG from the LNG storage tanks. Operational emissions from these engines will be controlled through Selective Catalytic Reduction (SCR) control technology. The SCR will constitute Best Available Control Technology for NO_x, CO, and VOC emissions. NO_x emissions will be reduced by 83 percent overall, CO emissions will be reduced by about 87 percent using an oxidation catalyst and VOC emissions will be reduced by 70 percent. A detailed discussion of these BACT systems is included in Section 5 of this application.

The Wartsila 18V32DF is a dual fuel backup generator engine equipped to burn diesel fuel in the event that natural gas is not available. An additional diesel-fueled emergency generator will also be installed for backup emergency power for the Project. During initial start up (commissioning) of the FSRU, the Wartsila 18V32DF dual fuel backup generator will be operated on diesel fuel to provide electricity, along with the emergency diesel generator. These generator engines will be utilized 100% during start up operations, until LNG is unloaded into the FSRU and BOG becomes available. Following the commissioning period, the Wartsila diesel-powered emergency generator will function as a standby unit, effectively utilized at about 2 percent for startup maintenance and emergency backup conditions, not to exceed 200 hours per year. Emissions were calculated assuming this engine will operate 100 hours utilizing natural gas, and 100 hours utilizing diesel fuel. The engine's exhaust emissions will be controlled by the SCR while operating on natural gas fuel. The diesel-fueled emergency generator will also have an annual operating limit of 200 hours.

A diesel - fueled firewater pump engine will be operated only in event of an emergency, but will undergo routine operations at a utilization of about 2 percent to insure successful startup when necessary, which will not exceed 200 hours per year. The emergency lifeboat engine will be a minor emission source. The emergency lifeboat's 75-Hp diesel engine will be used for approximately 50 hours per year due to start-up maintenance.

BOG from vaporization of LNG, which will fuel the main generator engines and the SCVs, will be pipeline quality natural gas containing only trace amounts of sulfur. Diesel engines will be supplied with low sulfur (sulfur compounds less than 15 ppm by weight) diesel fuel. Therefore, SO_2 emissions from the Project are expected to be less than significant. Small amounts of PM_{10} and $PM_{2.5}$ will be produced from these natural gas combustion sources at the FSRU and will have a less than significant impact on the air quality. Since natural gas is lead-free and diesel fuel contains only trace amounts, lead will not be emitted in significant quantities from any of the Project sources.

The regasification of LNG to natural gas takes place within the SCV process. A water bath contains fresh water generated by the collection of condensation on cold LNG piping and from a by-product of combustion exhaust gases vented into the water bath. The water bath is heated via SCV heaters fueled by the BOG. The combustion and vaporization process is thermally stabilized by submersion in the water bath.

LNG enters the heated water bath via submerged piping. Heat is transferred to the submerged piping vaporizing LNG to natural gas, which exits the SCV to the pipeline header and natural gas send out equipment. Combustion exhaust gas is sparged through the water bath. The source of emissions is the natural gas-powered heater, where NO_x emissions are expected at about 40 ppm. The water bath is treated with bicarbonate of soda to neutralize the acid from exhaust gases, and can be reused. The water bath is continually maintained by the condensate and water from the combustion exhaust. A maximum of five of the eight SCV units will operate at any one time at 100% load throughout the year.

Some breathing losses and small amounts of working losses of VOCs will occur from the diesel storage tank. The tank will be kept full but will not be utilized after commissioning except for emergency diesel engine fueling. During facility operations, the diesel fuel tank will have a capacity of approximately 88,000 gallons.

Electro-hydraulic powered cranes will be utilized for material handling and offloading of supplies from the supply boat. The fuel gas compressor, BOG compressor, loading arms, various pumps, heaters, scrubbers, fork lifts, hand trucks, and utility equipment will be powered by electricity generated by the internal combustion (IC) engine generators, and would be exempt from air permitting. Electric- powered equipment is not a source of air pollution.

Some of the ammonia formed from the urea injected upstream of the SCR catalyst to control NO_x from the generator engines will pass the through the process unreacted and escape into the air. This is referred to as “ammonia slip.” The ammonia slip emissions from this Project will be limited 1.6 pounds per hour (lb/h) in the exhaust (corrected to 15 percent oxygen O_2).

Ammonia is not a carcinogen, but it can have chronic and acute adverse human health impacts. The nearest sensitive receptor is onshore about 13.9 miles from the FSRU location. A health risk screening analysis to conservatively estimate the long-term (chronic) non-cancer risk, and short-term (acute) non-cancer risk associated with the maximum ammonia emissions was not required for this project.

The mobile source assist marine vessels associated with the project include the following:

- Tugboats used for moorings at the FSRU;
- One supply boat; and
- One crew boat.

The crewboat will operate one time a week for the 7-day shift change. The supply boat will operate once a week to bring supplies to the FSRU and haul black waste from the FSRU back to shore for disposal.

LNG carrier emissions are calculated for natural gas powered vessels, rated at 45,600 Hp on average. Assist tug vessel emissions, based on average rating of 9,250 Hp, for the two tugs associated with each LNG carrier berthing, unloading, deberthing and departure, are calculated at three miles from the FSRU.

3.3 GREENHOUSE GAS EMISSIONS (GHG)

Although CO_2 is not a regulated pollutant, it is associated with GHG emissions, along with other gases such as methane and chloroflurocarbons (CFCs). GHG are vital to life on earth because they help to maintain the ambient temperatures. However, excess

GHG emissions augment this effect and contribute to overall global climatic changes, typically referred to as global warming. CO_2 emissions are a product of fossil fuel combustion and tropical forest destruction, human activities that contribute to global climatic changes. Large quantities of GHG emissions will decrease the amount of infrared or heat energy radiated by the earth back to space and upset the heat balance. Global warming may ultimately contribute to a rise in sea level, destruction of estuaries and coastal wetlands, and changes in regional temperature and rainfall pattern, with significant agricultural and coastal community implications.

Among the fossil fuels, coal has the highest carbon content, while natural gas contains about 60 percent the carbon content of coal. Compared to other fossil fuels, natural gas is a relatively clean-burning and efficient fuel that emits fewer pollutants, including CO_2.

BHPB is committed to reducing GHG emissions, even though the United States does not yet regulate these emissions (BHPB 2002). The emissions summary table in Appendix A shows the Project estimated CO_2 emissions. BHPB keeps an accounting of its GHG emissions and will continue to do so with this Project. GHG will be emitted under normal operations, as well as under any unplanned releases of LNG.

3.4 NON–CRITERIA POLLUTANTS

The proposed project will not produce significant emissions of the nine regulated non-criteria pollutants. The nine regulated non-criteria pollutants are asbestos, beryllium, mercury, vinyl chloride, fluorides, sulfuric acid mist, H_2S, total reduced sulfur (including H_2S), and reduced sulfur compounds (including H_2S). Routine operations use natural gas for fuel, and thus would not emit any of these pollutants. Non-routine operations that could produce any of these pollutants are infrequent enough to create any significant emissions. Hazardous air pollutant (HAPS) emissions have been calculated for the Project. These HAPS emissions are summarized in Appendix A. This summary demonstrates that the Project is not a major source of HAPS.

3.5 PIPELINE OPERATIONS

Operation of the pipeline will not result in substantial air emissions under normal operating conditions, since the pipeline would be installed underground and underwater and is a closed system. Typically, only minor emissions of natural gas, called fugitive emissions, occur from pipeline connections at aboveground locations. Because such emissions are typically very small, they are not regulated by permit or source-specific requirements, but fugitive leaks from the FSRU process equipment will be composed of primarily methane.

A minor release of LNG to the water is unlikely to present any significant air quality impact. The extent of impact would be dependent not only on the size of a release but also on wind and water conditions at the time of a release. LNG is less dense than water, and it would boil rapidly when exposed to the water temperature. Because of the density and turbulence created by the rapid boiling, an LNG spill would spread rapidly and would vaporize rapidly. Air quality would not be impacted because the LNG contains no VOC.

3.6 CRITERIA POLLUTANT EMISSION FACTORS

The primary criteria pollutant emissions from this facility are NO_x, VOC, CO, SO_2, and PM_{10}. The amount of criteria pollutant emissions are calculated using the emission factors listed in the Emissions Summary Table in Appendix A.

3.7 EMISSION CALCULATIONS

Emission calculations and data for the project are enclosed as Appendix A. The emissions data spreadsheets are organized as follows for review:

- *Construction Emissions:* This spreadsheet lists resultant emissions and assumptions used to calculate emissions for construction activities.
- *FSRU Equipment List:* This spreadsheet lists emissions data for the operating equipment.
- *FSRU Controlled and Uncontrolled Emissions Summary*: These spreadsheets list the following data: Device notes detailing conditions used to calculate emissions, emission factors used for emissions calculations, and resultant emissions in tons per year for criteria and hazardous air pollutants.
- *(2) 20V34SG UNC:* This spreadsheet shows detailed uncontrolled emission calculations and operating conditions for two Wartsila 20V34SG generators in operation.
- *(2) 20V34SG BACT:* This spreadsheet shows detailed emissions calculations and operating conditions with the application of BACT for two Wartsila 20V34SG generators in operation.
- *(2) 20V34SG Reduction:* This spreadsheet shows percent emission reduction from the BACT emission controls for two Wartsila 20V34SG generators in operation.
- *Urea Mass Balance:* This spreadsheet lists emissions data for urea used for the SCR units.

- *18V32DF Gas UNC:* This spreadsheet shows detailed uncontrolled emissions calculations and operating conditions with gas fuel for the dual fuel generator, Wartsila 18V32DF.
- *18V32DF Diesel UNC:* This spreadsheet shows detailed uncontrolled emissions calculations and operating conditions with diesel fuel for the dual fuel generator, Wartsila 18V32DF.
- *18V32DF Gas BACT:* This spreadsheet shows detailed emissions calculations and operating conditions with the application of BACT for the dual fuel generator, Wartsila 18V32DF.
- *18V32DF Diesel BACT:* This spreadsheet shows detailed emissions calculations and operating conditions with the application of BACT (South Coast Air Quality Management District limits) for the dual fuel generator.
- *(5) SCV Controlled:* This spreadsheet details emission parameters and controlled resultant emission rates for five SCVs at 8000 hours per year operation.
- *Firewater Pump:* This spreadsheet details emission parameters and resultant emission rates for the firewater pump at 200 hours per year operation.
- *Emergency Generator:* This spreadsheet details emission parameters and resultant emission rates for the emergency generator at 200 hours per year operation.
- *Freefall Lifeboat*: This spreadsheet details emission parameters and resultant emission rates for the freefall lifeboat at 50 hours per year operation.
- *Diesel Storage Tank:* This spreadsheet details emissions from the 4000 gallon diesel storage tank using SCAQMD AP-42 fixed roof equations.
- *Scarborough LNG:* This spreadsheet provides the fuel constituents for the natural gas fuel.
- *Vessels: Controlled Summary:* These spreadsheets list the following controlled emissions data: Vessel notes detailing conditions used to calculate emissions, emission factors used for emissions calculations, and resultant emissions in tons per year.
- *Vessels: Uncontrolled Summary:* These spreadsheets list the following uncontrolled emissions data: Vessel notes detailing conditions used to calculate emissions, emission factors used for emissions calculations, and resultant emissions in tons per year.
- *Vessels with Gas Carriers*: This spreadsheet details gas carrying vessel emissions and operating conditions used to calculate the emissions.

- *Vessels with all Diesel*: This spreadsheet details diesel vessel emissions and operating conditions used to calculate the emissions.
- *(2) Assist Tug Mains*: This spreadsheet details the following data for the assist tug main engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *(2) Assist Tug Bow*: This spreadsheet details the following data for the assist tug bow thruster engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *(2) Assist Tug Gen*: This spreadsheet details the following data for the assist tug generator engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *Assist Tug Activity*: This spreadsheet lists the assumptions used in the assist tug emission calculations.
- *Crew Boat Mains*: This spreadsheet details the following data for the crew boat main engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *Crew Boat Gen*: This spreadsheet details the following data for the crew boat generator engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *Crew Boat Activity*: This spreadsheet lists the assumptions used in the crew boat emission calculations.
- *Supply Boat Mains*: This spreadsheet details the following data for the supply boat main engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *Supply Boat Bow*: This spreadsheet details the following data for the supply boat bow thruster engines: Detailed vessel notes explaining operating conditions and parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *Supply Boat Gen*: This spreadsheet details the following data for the supply boat generator engines: Detailed vessel notes explaining operating conditions and

parameters used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.

- *Supply Boat Activity*: This spreadsheet lists the assumptions used in the supply boat emission calculations.
- *LNG Carrier (California Diesel)*: This spreadsheet details the following data for the LNG Carriers operating on California grade diesel fuel (15 ppm sulfur by weight): Detailed vessel notes explaining operating conditions and parameters for different types of fuels used to calculate emissions, emission factors used for emissions calculations, and resultant emissions.
- *LNG Carrier (Gas)*: This spreadsheet details the following data for the LNG Carriers operating on LNG: Detailed vessel notes explaining operating conditions and parameters for different types of fuels used to calculate emissions, emission factors used for emission calculations, and resultant emissions.
- *LNG Carrier Activity*: This spreadsheet lists the assumptions used in the LNG carrier emission calculations.

4.0 REGULATORY ANALYSIS

This section addresses the federal, state, and local air quality requirements for the emissions associated with this Project

4.1 FEDERAL AIR QUALITY REGULATIONS

The Clean Air Act (CAA) of 1970, 42 USC 7401 et seq. as amended in 1977 and 1990 is the basic Federal statute governing air quality. The provisions of the CAA that are potentially relevant to this Project are listed below and discussed in the following sections:

- Air Quality Control Regions (AQCR);
- National Ambient Air Quality Standards (NAAQS);
- New Source Review (NSR) Standards;
- Prevention of Significant Deterioration (PSD);
- New Source Performance Standards (NSPS);
- National Emission Standards for Hazardous Air Pollutants (NESHAPs); and
- Title V Operating Permits (Title V).

4.1.1 Air Quality Control Regions (AQCR)

Because air pollution is a regional problem and not limited to political or state boundaries, the CAA established Air Quality Control Regions (AQCR) as a method of dividing the country into regional air basins. The Project would be located offshore and the pigging station would be located onshore in Ventura County, which belongs to the Metropolitan Los Angeles AQCR (40 CFR Part 81.17).

4.1.2 National Ambient Air Quality Standards (NAAQS)

Ambient air quality is protected by Federal and state regulations. Under requirements of the CAA, the USEPA has developed primary and secondary NAAQS for six criteria air pollutants, including: ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter less than 10 microns (PM_{10}). Additionally, a new particle size of 2.5 μm or less ($PM_{2.5}$) was recently promulgated by the USEPA. The criteria pollutants are described in more detail below. Areas of the country that are currently in violation of NAAQS are classified as nonattainment areas, and new sources to be located in or near these areas could be subject to more stringent air permitting requirements.

The NAAQS, other than O_3, particulate matter, and those based on averages, are not to be exceeded more than once a year. The eight-hour O_3 standard is attained when the fourth highest eight-hour concentration in a year, averaged over three years, is equal to or less than the standard of 0.08 ppm. Extreme O_3 nonattainment, as is the case in the Project area, is assigned when this average is 0.280 ppm and above. PM_{10} is attained when 99 percent of the daily concentrations, averaged over three years, are equal to or less than the standard.

Gasoline and diesel fuel combustion sources emit these criteria air pollutants, along with volatile organic compounds (VOCs), a precursor of O_3. The primary standards were designed to protect public health while the secondary standards protect public welfare, predominately visibility. NAAQS have been developed for specific durations of exposure over specific averaging times. The NAAQS for NO_2 is 100 micrograms per cubic meter (ug/m^3) or 0.053, ppm over an annual average. The standard for CO is 10 milligrams per cubic meter (mg/m^3) (9 ppm), with an 8-hour average concentration not to be exceeded more than once per year. In addition to the 8-hour CO standard, there is a 1-hour average standard of 40 mg/m^3 (35 ppm). For O_3, a new 8-hour standard will replace the current 1-hour standard (see discussion below). Particulate matter standards have both a 24-hour average and an annual arithmetic mean standard. The NAAQS program also classifies areas where sufficient data are available as either attainment (does not exceed NAAQS) or non-attainment (exceeds NAAQS). The NAAQS are codified in 40 CFR Part 50 and summarized in Table 4.1-1.

Additionally, in 1997 the USEPA announced new NAAQS for ground-level O_3, following a lengthy scientific review. The new standard was based on 8-hour O_3 readings to better protect health and the environment than the current 1-hour O_3 standard. The 1-hour O_3 standard has continued while the 8-hour standard was litigated. The U.S. Supreme Court upheld the USEPA's 8-hour O_3 standard in February 2001. As a consequence, some areas of the country currently in attainment for O_3 may no longer be in attainment once the new standard is implemented (USEPA expects to promulgate designations for the 8-hour O_3 standard by 2004).

In 1997, the USEPA also proposed new standards for $PM_{2.5}$, to regulate very fine particles that penetrate deeply into the lungs and cause adverse health effects. These new standards were upheld by the U.S. Supreme Court in February 2001. The $PM_{2.5}$ standard cannot be implemented, however, until the USEPA and the states collect 3 years of monitoring data to determine which areas are not attaining the standard. Designation of attainment or nonattainment for $PM_{2.5}$ would likely occur in 2004 or 2005.

The criteria pollutants and their impact upon health and environmental welfare are discussed in the following subsections. Onshore ambient air monitoring data from Ventura County is included in this discussion. The Air Quality Impact Analysis in Section 6.0 of this application utilizes this data in predicting project emission impacts on the onshore nonattainment area.

Ozone

O_3 is a photochemical oxidant and the major component of smog. While O_3 in the upper atmosphere is beneficial for shielding the earth from harmful ultraviolet radiation from the sun, high concentrations at ground level cause health problems due to lung irritation. O_3 is generated by a complex series of chemical reactions between VOCs and nitrogen oxides (NO_x) in the presence of ultraviolet radiation. High O_3 levels result from VOCs and NO_x emissions from vehicles and industrial sources, in combination with daytime wind flow patterns, mountain barriers, a persistent temperature inversion, and intense sunlight. For this reason, VOC and NO_x are considered precursors to O_3 and are consequently regulated as O_3.

Background O_3 data from the air quality monitoring stations at El Rio-Rio Mesa School in Oxnard and Ventura-Emma Wood State Beach are provided in Tables 4.1-2 and 4.1-3, respectively, in ppm for both the 1-hour and the 8-hour O_3 standards. The 1-hour standard for the State of California is 0.09 ppm, whereas the Federal 1-hour standard is 0.12 ppm. The Federal 8-hour standard is 0.08 ppm. These stations are the closest monitoring stations to the Project that collect ambient O_3 data. Data indicate that O_3 levels have fallen since 1995, and number of days exceeding the state and federal standard have decreased. In the four years from 1998 to 2001, neither state nor federal O_3 standards were exceeded at the Ventura-Emma Wood State Beach area. The El Rio-Rio Mesa School monitoring site showed no state or federal exceedances from 2000 to 2001, and only one-day exceedance of the state standard during each year of 1998 and 1999. This is a considerable improvement from eight days exceeding the state standard in 1996 and four days' exceedance of the Federal 8-hour standard.

In assessing the South Central Coast Air Basin as a whole, a significant number of both state and federal exceedances of the O_3 standard have occurred in recent years (see Table 4.1-4). In 2002, the Basin exceeded the state 1-hour O_3 standard 23 days, the federal 1-hour standard 2 days, and the federal 8-hour standard 16 days. However, many occurrences of days exceeding both state and federal O_3 standards occur in the inland areas of Ojai and Simi Valley, where offshore breezes blowing from the coast carry pollution across the county and over mountain passes. In 1991, the number of days the state 1-hour O_3 standard was exceeded was 112, and in 2001, the number of days was reduced to 34. Likewise, the federal 1-hour standard was exceeded 94 days in 1991, and only 25 days in 2001. Further, the 3-year 4^{th} high average of the 8-hour O_3 concentration was 0.17 ppm in 1991, and 0.128 ppm in 2001. Although the O_3 trends are showing a significant reduction over the past 10 years, Ventura County remains in severe nonattainment of the state's 1-hour O_3 standard.

Nitrogen Dioxide (NO_2)

NO_x emissions are primarily generated from the combustion of fuels. NO_x include nitric oxide and NO_2. Because nitric oxide converts to NO_2 in the atmosphere over time and NO_2 is the more toxic of the two, NO_2 is the listed criteria pollutant. It can penetrate deep into the lungs where tissue damage occurs. The control of NO_x is also important because of its role in the formation of O_3.

Background NO_2 data for El-Rio-Rio Mesa School and Ventura monitoring station ID 61113001-1 are provided in Table 4.1-5. Background NO_2 data for Ventura-Emma Wood State Beach and Ventura monitoring station ID 61112003-1 are provided in Table 4.1-6. Background NO_2 data for Oak View and Ventura monitoring station ID 61110005-1 are provided in Table 4.1-7. As supported by these tables, the County has been in attainment of NO_2 for many years.

Carbon Monoxide (CO)

CO is a product of incomplete combustion, principally from automobiles and other mobile sources of pollution. CO emissions from wood-burning stoves and fireplaces can also be measurable contributors. The major immediate health effect of CO is that it competes with oxygen in the blood stream and can cause death by asphyxiation. However, concentrations of CO in urban environments are usually only a fraction of those levels of which asphyxiation can occur. Peak CO levels occur typically during winter months, due to a combination of higher emission rates and stagnant weather conditions.

Background CO data for various Ventura monitoring stations are provided in 4.1-8 and 4.1-9. These tables indicate that Ventura County is in attainment of the CO standard.

Sulfur Dioxide (SO_2)

SO_2 is produced when any sulfur-containing fuel is burned. It is also emitted by chemical plants that treat or refine sulfur or sulfur-containing chemicals. Health and welfare effects attributed to SO_2 are due to the highly irritant effects of sulfate aerosols, such as sulfuric acid, which are produced from SO_2. Natural gas contains trace amounts of sulfur, while fuel oils contain much larger amounts. SO_2 can increase the occurrence of lung disease and cause breathing problems for asthmatics. It reacts in the atmosphere to form acid rain, which is destructive to lakes and streams, crops and vegetation, as well as to buildings, materials, and works of art.

Background SO_2 data is provided in Table 4.1-10 for El Rio-Rio Mesa School and Ventura monitoring station ID 061113001-1. This table is representative of Ventura County and shows that the County is in attainment for SO_2.

Particulate Matter

Particulates in the air are caused by a combination of wind-blown fugitive or road dust, particles emitted from combustion sources (usually carbon particles), and organic sulfate and nitrate aerosols formed in the air from emitted hydrocarbons, sulfur oxides, and NO_x. Particulate matter may contribute to the development of chronic bronchitis and may be a predisposing factor to acute bacterial and viral bronchitis. Respirable particulate matter is referred to as PM_{10}, because it has a diameter size of equal to or less than 10 microns. Respirable particulate can contribute to increased respiratory disease, lung damage, cancer, premature death, reduced visibility, and surface soiling. In 1987, the USEPA adopted standards for PM_{10} and phased out the total suspended particulate (TSP) standards that had been in effect until then. As discussed previously, the USEPA also recently adopted standards for $PM_{2.5}$. Fine particulates come from fuel combustion in motor vehicles and industrial sources, residential and agricultural burning, and from the reaction of NO_x, SO_x and organics.

Background PM_{10} data from El Rio-Rio Mesa School are provided in Table 4.1-11 in micrograms per cubic meter ($\mu g/m^3$). As shown by the table, Ventura County has not been in attainment of the state PM_{10} standards since 1986, but had attained the Federal standard from 1998 through 2001. In 2002, it exceeded the standard by six days. The PM_{10} trends summary for the South Central Coast Air Basin is shown in Table 4.1-12. Historical background data for $PM_{2.5}$ are not available, since the $PM_{2.5}$ standards are not yet finalized, as discussed in the section on NAAQS.

Lead

Lead exposure can occur through multiple pathways, including inhalation of air, and ingestion of lead in food from water, soil, or dust contamination. Excessive exposure to lead can affect the central nervous system. Lead gasoline additives, non-ferrous smelters, and battery plants were a significant contributor to atmospheric lead emissions. Legislation in the early 1970's required gradual reduction of the lead content of gasoline over a period of time, which has dramatically reduced lead emissions from mobile and other combustion sources. In addition, unleaded gasoline was introduced in 1975, and together these controls have essentially eliminated violations of the lead standard for ambient air in urban areas. Hence, many states do not provide a background level for lead.

Background levels for lead from Ventura monitoring station ID 06112002-7 are provided in Table 4.1-13. This table supports the attainment status of the South Central Coast Air Basin for lead.

4.1.3 Federal New Source Review (NSR) Requirements

In order to prevent new sources of emissions from deteriorating existing air quality beyond acceptable levels, a federal review process was established. There are separate procedures for federal pre-construction review of certain large proposed projects in attainment areas versus non-attainment areas. NSR is a federal pre-construction review for affected sources in non-attainment areas. The Project will be located offshore, outside the boundaries of a Corresponding Onshore Area, and in a general area designated "unclassified". An unclassified area designation is one that has not been classified as in attainment or nonattainment with respect to NAAQS by USEPA due to the lack of collection and analysis of air quality data. Therefore, since the Project will reside in an unclassified area, the Project would not be subject to local air permitting.

4.1.4 Prevention of Significant Deterioration (PSD)

PSD Permit Applicability

The regulations under the Federal Prevention of Significant Deterioration (PSD) program, administered by the EPA, are intended to preserve the existing air quality in areas where pollutant levels are below the NAAQS. The following three criteria are used to determine PSD applicability: 1) Whether the proposed project is sufficiently large (in terms of its emissions) to be a "major" stationary source or "major" modification; 2) Whether the source is located in a region designated as "attainment" or "unclassified";

and 3) Whether the pollutants emitted from a major stationary source exceed the significant emission rates defined by 40 CFR 52.21.

PSD regulations impose specific limits on the amount of pollutants that major new or modified stationary sources may contribute to existing air quality levels. Major sources are defined as facilities with a potential to emit listed pollutants in amounts equal to or greater than 250 tons per year or 100 tons per year for 28 specific stationary source categories. Uncontrolled CO emissions outlined in Appendix A show CO emission estimates at 265.1 tons per year. Therefore, the proposed Port Cabrillo Terminal will be a major source of criteria air pollutants under the PSD permitting program. Since the Terminal will be located 14 miles offshore, it will be administered by the USEPA Region IX in an unclassified air quality attainment area.

Significant Emission Requirements

In addition, a facility is subject to PSD review when emissions associated with a major new source are "significant". Significant emission thresholds (tons per year) for criteria pollutants are as follows:

- Carbon monoxide (CO): 100
- Nitrogen oxides (NO_2): 40
- Sulfur dioxide (SO_2): 40
- Ozone / VOC: 40
- Particulate Matter (PM_{10}): 15

The Project emissions outlined in Appendix A show that estimated uncontrolled emissions for CO (265.1 tons / year), NO_2 (184.9 tons / year), and VOC (77.1 tons / year) exceed these significant emission levels. The PSD applicability determination is the process of determining whether a pre-construction review is required in accordance with 40 CFR Part 52.21. The PSD review consists of: 1) a case-by-case BACT determination; 2) an ambient air quality analysis to determine if the proposed construction will cause or significantly contribute to a violation of the NAAQS or PSD increment; 3) possible ambient air monitoring; 4) an assessment of the effects on visibility, industrial growth, soil, and vegetation; and 5) an opportunity for public comment.

This application addresses each of these PSD review requirements. Section 5.0 presents a BACT analysis for the applicable pollutants. Section 6.0 presents an air quality impact analysis, and Section 7.0 presents additional Project impact analyses such as visibility, growth, soil and vegetation, and threatened and endangered species impacts.

4.1.5 New Source Performance Standards (NSPS)

NSPS applies to new sources in designated source categories to reflect the degree of emission limitation achievable through BACT and these standards are published in Title 40 of the CFR (40 CFR part 60). NSPS for small industrial, commercial-institutional steam generating units (Subpart Dc) are applicable to the submersible combustion vaporizers (SCV). However, since the SCVs will be fired on natural gas, emission standards and monitoring requirements do not apply, but recordkeeping and reporting requirements will apply.

4.1.6 National Emission Standards for Hazardous Air Pollutants (NESHAP)

NESHAPs Part 61 and 63 regulate the emission of hazardous air pollutants (HAPs) from existing and new sources. However, the Project is not expected to operate any processes that are regulated by Part 61. Part 63 provides standards for major sources of HAPs. The CAA Amendments of 1990, under revisions to Section 112, required the USEPA to list and promulgate NESHAPs to reduce the emissions of HAPs, (such as formaldehyde, benzene, xylene, and toluene) from categories referred to as “major sources” and “area sources”. As these standards are promulgated, they are published in Title 40, CFR Part 63. Stationary gas reciprocating engines are listed among the source categories that would be subject to emission standards. Standards for these engines that were scheduled for promulgation by November 15, 2000 have missed the regulated deadline of May 15, but were recently proposed on November 26, 2002. Until these standards are final, however, stationary gas reciprocating engines are now subject to the “MACT hammer” which means they are applicable to Maximum Achievable Control Technology (MACT) standards on a case-by-case basis as determined by the regulating agency. However, the proposed Project would not be subject to the MACT standards because it is not a major source of HAPs. A major HAPS source is defined as having an emissions threshold of 10 tons a year or greater of any one HAP, or a combination of HAPS at 25 tons per year or greater. The proposed Project would be a minor source of HAPs because it will not emit HAPs at either the 10-ton or the 25-ton thresholds due to the use of natural gas, which has a high methane and low VOC composition, as the primary fuel. In addition, the oxidation catalyst installed as a control device will further reduce HAPS emissions. Therefore, NESHAP Part 63 will not apply. Documentation of HAPS emissions is included in Appendix A.

The USEPA recently promulgated NESHAPs for natural gas transmission and storage facilities (40 CFR 63 Subpart HHH). Owners and operators of facilities that only transport natural gas are not subject to this regulation if their facility does not contain a glycol dehydration unit. This Project will not be subject to Subpart HHH.

4.1.7 Title V Operating Permits

Title V of the CAA Amendments of 1990, as outlined in 40 CFR Part 71 (Part 71 Operating Permit), requires a Federal Operating Permit for major sources of regulated pollutants and a compliance plan for meeting each regulatory requirement. Part 71 Operating Permits are managed by the USEPA where state Title V (Part 70 Operating Permit) programs do not apply. Additionally, the owner/operator must file a compliance certification annually stating that the facility complies with all applicable air regulations, and must renew the permit every five years. Designation of a major source is contingent on the attainment status of the air basin. Given that the Project will be located in OCS waters offshore of Ventura, which is an attainment area, the major source threshold is based on a potential-to-emit of 100 Tpy of a criteria pollutant, 10 Tpy for a single HAP, or 25 Tpy for all HAPs combined. The project will require a Title V Operating Permit under the jurisdiction of USEPA Region IX. A Title V permit application will be submitted to the USEPA for this project.

Compliance Assurance Monitoring

The Federal Title V Operating Permit will list all federally enforceable air regulations and a compliance plan for meeting each regulatory requirement. In accordance with U.S. EPA, as published at 40 CFR Part 64, a Compliance Assurance Monitoring Plan must be prepared for each piece of equipment proposed for operation at a new or modified facility. U.S. EPA requires Compliance Assurance Monitoring Plans for all new major sources, as well as for existing sources at the required five-year renewal application. According to 40 CFR Part 64.2, all major sources required to obtain a Part 71 permit are subject to these provisions, with the exception of municipally owned backup utility units.

In order to demonstrate compliance with emission limitations, emission monitoring shall meet general criteria where the monitoring shall be designed to obtain data for appropriate indicators of emission control equipment performance. These indicators can include direct or predicted emissions, process, and control device parameters affecting control efficiency, or records of inspection and maintenance activities. Appropriate ranges or conditions for the selected indicators shall be established so that equipment operation with the range or under the conditions demonstrates compliance with emission limitations. In addition, indicator ranges or conditions shall be designed as follows: 1) based on a single value; 2) expressed as a function of process variables; 3) expressed as maintaining the applicable parameter in a particular operational status; or 4) established as interdependent between more than one indicator.

Emission monitoring shall also meet performance criteria where data must be representative of the emissions or parameters being monitored, and for new equipment, verification procedures confirming operational status of the monitoring prior to the date by which monitoring is required. Adequate quality assurance and control practices must also be in place to ensure the continued validity of the data.

Documentation that satisfies the monitoring design criteria will be submitted to USEPA, Region IX. The documentation must contain the following: 1) indicators to be monitored and their ranges or conditions; and 2) performance criteria, and if applicable the performance criteria for any continuous emissions monitoring systems. The Project will comply with CAM for all applicable equipment. An initial Compliance Plan and Compliance Certification forms will be included in the Title V permit application.

4.1.8 Additional Federal Regulations

The Outer Continental Lands Act (OCSLA) requires the Secretary of the Interior to promulgate and administer regulations that comply with the CAA. The regulations that apply to air quality are published at 30 CFR Part 250.303 and enforced by the MMS. However, the MMS does not have air quality permitting authority since the Project is not subject to the OCSLA.

4.2 STATE AIR QUALITY REGULATIONS

In 1989, California established state ambient air quality standards, including stringent enforcement of the NAAQS and additional standards for visibility reducing particles, sulfates, and hydrogen sulfide. Local districts prepare air quality plans to demonstrate how the ambient air quality standards will be attained. Ventura County must comply with the California CAA. It is designated as a severe O_3 nonattainment area and is also in nonattainment for the state PM_{10} standard. The California ambient air quality standards and the NAAQS are both shown in Table 4.1-1.

As discussed in the section on NAAQS in the Federal regulatory section above, the CAA Amendments of 1970 empowered the USEPA to promulgate air quality standards for six common air pollutants: O_3, CO, lead, NO_2 (or NO_x), particulates (based on particle size of 10 microns, or μm, or less, or $PM_{10,}$ and particle size of 2.5 μm or less, or $PM_{2.5}$), and SO_2. These standards were to include primary standards designed to protect health and secondary standards to protect public welfare, predominately visibility. The NAAQS reflect the relationship between pollutant concentrations and health and welfare effects, and are therefore supported by sound scientific evidence. The state has established California ambient air quality standards (CAAQS) for the criteria pollutants, which are as stringent or more stringent than the NAAQS.

Both the state and national air quality standards are based on an allowable concentration of a pollutant and an averaging time over which the concentration is measured. Allowable concentrations are based on studies of the effects of pollutants on human health, crops, vegetation, and damage to building materials. The averaging times are based upon whether damage is more likely to occur during a short time (e.g., 1 hour) or a longer period (e.g., 8 or 24 hours, or 1 month). Some pollutants have standards reflecting both short-and long-term effects. The health effects associated with each pollutant are also outlined in Table 4.1-1. This table also summarizes the state and federal primary and secondary standards for the six pollutants and the averaging time for determining compliance with the standards. Data from three California Air Resources Board (ARB) air quality monitoring stations closest to the Project are discussed above. The air quality impact analysis contained in Section 6.0 of this application presents the Project's impact on State of California air quality standards. This analysis demonstrates that the emissions from this Project will not exceed any of those standards for the impacts on the onshore nonattainment area.

4.2.1 Particulate Sulfates

Particulate sulfates are the product of further oxidation of SO_2. Sulfate compounds consist of primary and secondary particles. Primary sulfate particles are directly emitted from open pit mines, dry lakebeds, and desert soils. Fuel combustion is another source of sulfates, both primary and secondary. Secondary sulfate particles are produced when oxides of sulfur (SO_x) emissions are transformed into particles through physical and chemical processes in the atmosphere. Particles can be transported long distances. The South Central Coast Air Basin, including Ventura County, is in attainment with the state standard for sulfates, and there is no federal standard. The three gas-fired generators on the FSRU would emit small quantities of particulate sulfates as a by-product of NO_x emission controls, and their effect will be less that significant.

4.2.2 Other State-Designated Criteria Pollutants

Along with sulfates, California has designated hydrogen sulfide and visibility-reducing particles as criteria pollutants, in addition to the Federal criteria pollutants. The entire State is in attainment for visibility-reducing particles, and the South Central Coast Basin is in attainment for hydrogen sulfide. Due to the use of natural gas as the Project's primary fuel, hydrogen sulfide and visibility-reducing particle emissions are expected to be insignificant.

4.2.3 Consistency with State and Local Requirements

State law establishes local air pollution control districts and air quality management districts with the responsibility for regulating emissions from stationary sources. As discussed previously in this section, the USEPA is to be the lead-permitting agency for this project. However, in order to provide the USEPA with federally enforceable permit conditions, the following is a listing of the VCAPCD SIP rules, which are applicable to this Project. Also included is a compliance analysis for each rule.

Rule 50, Opacity

Rule 50 prohibits the discharge of any air contaminant from a single source for more than three (3) minutes in any one hour that produces visible emissions of specified opacity or shade (designated on the Ringlemann Chart).

Analysis: No visible emissions are expected with proper, normal operation of the generators and the SCVs. BHPB is in compliance with this rule.

Rule 51, Nuisance

Rule 51 prohibits the discharge from any source of any air contaminant that may cause injury, detriment, nuisance, or annoyance to any considerable number of persons or the public, or which endangers such persons or public, or which may cause injury or damage to business or property.

Analysis: No nuisance is expected with proper, normal operation of the generators and the SCVs. BHPB is in compliance with this rule.

Rule 54, Sulfur Compounds

Rule 54 limits the concentration of sulfur compounds discharges from a source. For point source exhaust gases, the SO_2 concentration limit is 300 ppmv. For area sources, the ambient SO_2 concentration limit at the fenceline is 0.25 ppmv for 1-hour and 0.04 ppmv for 24-hour averaging times. For point source exhaust gases, the H_2S concentration limit is 10 ppmv. For area sources, the ambient H_2S concentration limit at the fenceline is 0.06 ppmv for 3-minute and 0.03 ppmv for 1-hour averaging times.

Analysis: The main generators and SCVs use natural gas as fuel exclusively. Burning natural gas in the main generators results in a stack gas concentration of 0.03 ppmv SO_2 and nondetectible H_2S. SO_2 stack gas concentration from the SCVs will be at 0.1 ppmv and nondetectible H_2S. The dual fuel generator (when operating on diesel fuel), backup generator, firewater pump, and lifeboat will all produce a maximum stack gas concentration of 0.29 ppmv SO_2 and nondetectible H_2S. They will be operated with diesel fuel with a 15 ppmv sulfur concentration. This analysis demonstrates that all sources of emissions are below the respective 300 ppmv and 10 ppmv limits required by this rule. Appendix A shows detailed calculations of sulfur compound concentrations in stack gas from all equipment onboard the FSRU. BHPB is in compliance with Rule 54.

Rule 57, Combustion Contaminants - Specific

Rule 57.B prohibits discharge of particulate matter emissions into the atmosphere from fuel-burning equipment in excess of 0.1 grains per cubic foot of gas (g/dscf).

Analysis: The main generators and SCVs use natural gas as fuel exclusively. Burning natural gas in the main generators results in a stack gas concentration of 0.0038 g/dscf PM_{10}. PM_{10} stack gas concentration from the SCVs will be at 0.0034 g/dscf. The dual fuel generator, backup generator, firewater pump, and lifeboat will all produce a maximum stack gas concentration below the limit as specified in this rule. Appendix A shows detailed calculations of particulate matter concentrations in stack gas from all equipment onboard the FSRU. BHPB is in compliance with Rule 57.

Rule 60, New Non-Mobile Equipment-Sulfur Dioxide, Nitrogen Oxides, and Particulate Matter

Rule 60 prohibits the building, erection, installation, or expansion of any non-mobile equipment unless the discharge into the atmosphere of contaminants will not and does not exceed any one or more of the following rates:

- 200 pounds per hour of sulfur oxides, calculated as sulfur dioxide;
- 140 pounds per hour of oxides of nitrogen calculated as nitrogen dioxide;
- 10 pounds per hour of combustion contaminants derived from the burning of fuel.

Analysis: Appendix A shows that all new non-mobile equipment onboard the FSRU emit contaminants below the emission limits specified in this rule. BHPB is in compliance with Rule 60.

Rule 62.1, Hazardous Materials

Rule 62.1 prohibits the discharge of hazardous materials from any source so as to result in concentrations at or beyond the property line in excess of any State, Federal or local standards or emission limits established.

<u>Analysis:</u> Reference Federal NESHAPs analysis in Section 4.1.6. BHBP is in compliance with this rule

Rule 63, Separation and Combination of Emissions

The requirements of Rule 63 apply to a single source that is emitting air contaminants through two or more emission points, or multiple sources where the air contaminants are combined prior to emission.

<u>Analysis:</u> All emission sources onboard the FSRU discharge into individual stacks. BHPB is in compliance with Rule 63.

Rule 64, Sulfur Content of Fuels

Rule 64 prohibits the burning of gaseous fuel with a sulfur content of more than 50 grains per hundred cubic feet (788 ppmv). Uncontrolled combustion of liquid fuel with a sulfur content exceeding 0.5% by weight is also prohibited.

<u>Analysis:</u> The main generators and SCVs use natural gas as fuel exclusively. The sulfur content of natural gas is limited 1 ppmv. The dual fuel generator, backup generator, firewater pump, and lifeboat run on diesel fuel with a sulfur content of 15 ppmv. BHPB is in compliance with Rule 64.

Rule 68, Carbon Monoxide

Rule 68 prohibits the discharge into the atmosphere CO in excess of 2000 ppmv.

<u>Analysis:</u> Appendix A shows that all equipment onboard the FSRU emit CO at a concentration below the emission limits specified in this rule. BHPB is in compliance with Rule 68.

Rule 74.2, Architectural Coatings

Rule 74.2 establishes requirements for any person who supplies, sells, offers for sale, or manufactures any architectural coating for use within the District, as well as any person who applies or solicits the application of any architectural coating within the District. Specifically, the rule limits the VOC content of paints and coatings.

<u>Analysis:</u> The use of any architectural coatings during the Project will follow the requirements and coating VOC limitations outlined in Rule 74.2

Rule 74.9, Stationary Internal Combustion Engines

Rule 74.9 limits the emissions from any stationary internal combustion engine rated at 50 or more horsepower, operated on any gaseous fuel. This rule applies to the three 20V34SG main generators. This rule does not apply to engines operated less than 200 hours per year, therefore it is not applicable to the Wartsila 18V32DF Backup Generator The applicable provisions of Rule 74.23 are:

(a) Pursuant to subsection B.1, NO_X emissions from a lean-burn engine must be limited to 45 ppmv, ROC emissions to 750 ppmv, and CO emissions to 4500 ppmv.

<u>Analysis:</u> The NO_X, ROC, and CO emission reduction system will enable compliance with subsection B.1. NO_x concentration will be controlled to 15 ppmv, ROC concentration to 43 ppmv, and CO concentration to 33 ppmv. See Appendix A for detailed emission calculations.

(b) Subsection B.5 prohibits ammonia slip in excess of 20 ppmv corrected to 15% oxygen.

<u>Analysis:</u> Ammonia slip emissions from this project will be limited to 1.6 pounds per hour or 10 ppmv.

(c) Subsection E contains recordkeeping requirements for the applicable parameters defined in Subsection E. Records shall be kept for a minimum of two (2) years and be subject to inspection.

<u>Analysis:</u> Records will kept as required by the Title V Permit.

BHPB will be in compliance with all provisions of this rule.

Rule 74.12, Surface Coating of Metal Parts and Products

Rule 74.12 applies to any person who applies or specifies the use of ROC containing surface coatings to metal parts or products.

Analysis: BHPB is exempt from the requirements of Rule 74.12 per Section C.3. Section C.3 states that Rule 74.12 does not apply to stationary sources emitting 200 pounds or less of ROC per rolling 12 month period. Monthly records will be maintained to substantiate this claim. BHPB is in compliance with Rule 74.12.

Table 4.1-1. California and Federal Ambient Air Quality Standards

Air Pollutant	State Standard	Federal Primary Standard	Most Relevant Effects
	Concentration/ Averaging Time	Concentration/ Averaging Time	
Ozone (O_3)	0.09 ppm, 1-hr. avg. (180 µg/m3)*	0.12 ppm, 1-hr avg.,(235 µg/m3) 0.08 ppm, 8-hr avg.** (157 µg/m3)	(a) Short-term exposures: (1) Pulmonary function decrements and localized lung edema in humans and animals (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide (CO)	9.0 ppm, 8-hr avg. (10 mg/m3) 20 ppm, 1-hr avg. (23 mg/m3)	9 ppm, 8-hr avg. (10 mg/m3) 35 ppm, 1-hr avg. (40 mg/m3)	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide ($N0_2$)	0.25 ppm, 1-hr avg. (470µg/m3)	0.053 ppm, annual arithmetic mean (100 µg/m3)	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide ($S0_2$)	0.04 ppm, 24-hr avg. (105µg/m3) 0.25 ppm, 1-hr. avg. (655µg/m3)	0.030 ppm, annual arithmetic mean (80 µg/m3) 0.14 ppm, 24-hr avg. (365 µg/m3)	(a) Bronchoconstriction accompanied by symptoms which may include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma
Suspended Particulate Matter (PM_{10}) Particulate Matter ($PM_{2.5}$)**	30 µg/m3, annual geo-metric mean 50 µg/m3, 24-hr avg. No State standard	50 µg/m^3, annual arithmetic mean 150 µg/m3, 24-hr avg. 15 µg/m^3, annual arithmetic mean 65 µg/m3, 24-hr avg.	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Excess seasonal declines in pulmonary function, especially in children

Table 4.1-1. California and Federal Ambient Air Quality Standards (continued)

Air Pollutant	State Standard	Federal Primary Standard	Most Relevant Effects
Sulfates	25 µg/m^3, 24-hr avg.	No Federal Standard	(a) Decrease in ventilatory function; (b) Aggravation of asthmatic symptoms; (c) Aggravation of cardio-pulmonary disease; (d) Vegetation damage; (e) Degradation of visibility; (f) Property damage
Lead	1.5 µg/m3, 30-day avg.	1.5 µg/m3, calendar quarter	(a) Increased body burden; (b) Impairment of blood formation and nerve conduction
Hydrogen sulfide	0.03 ppm (42 µg/m3)	No Federal Standard	Severe irritant to eyes and mucous membranes.
Visibility-Reducing Particles	In sufficient amount to reduce the visual range to less than 10 miles at relative humidity less than 70%, 8-hour average (10am – 6pm)	No Federal Standard	Visibility impairment on days when relative humidity is less than 70 percent

µg/m3 = microgram per meter cubed
ppm = parts per million
* Parenthetical value is an approximately equivalent concentration.
** The ozone 1-hour standard applies only to areas that were designated nonattainment when the ozone 8-hour standard was proposed in July 1997. This provision allows for a smooth, legal, and practical transition to the 8-hour standard. The ozone 8-hour standard and the $PM_{2.5}$ standards were recently promulgated after extended litigation and are included for information only until the USEPA can promulgate designations of attainment and nonattainment.
Source: California Air Resources Board 2002

Table 4.1-2. Background Air Pollution Data Summary for Ozone (O3) Trends at El Rio-Rio Mesa School #2

Year	Highest Concentration for O_3 (ppm)		Number of Days Exceeding Standard		
	1-hour	8-hour	State 1-hour	Federal 1-hour	Federal 8-hour
2001	0.094	0.066	0	0	0
2000	0.084	0.068	0	0	0
1999	0.103	0.070	1	0	0
1998	0.106	0.077	1	0	0
1997	0.102	0.081	2	0	1
1996	0.121	0.085	8	0	4
1995	0.124	0.084	7	0	3
1994	0.115	0.087	7	0	3
1993	0.138	0.091	8	1	3
1992	0.141	0.089	17	3	10
1991	0.120	0.089	12	0	12
1990	0.120	0.090	9	0	3
1989	0.190	0.103	18	2	9
1988	0.160	0.105	25	3	20
1987	0.180	0.104	33	5	21
1986	0.180	0.098	25	5	14
1985	0.150	0.096	28	3	15
1984	0.140	0.095	12	1	7
1983	0.150	0.097	20	7	10
1982	0.150	0.100	23	3	113
1981	0.160	0.103	29	8	15
1980	0.130	0.105	30	3	19

Sources of data: California Air Resources Board 2000; and USEPA 2002

Table 4.1-3. Background Air Pollution Data Summary for Ozone (O3) Trends at Ventura-Emma Wood State Beach

Year	Highest Concentration for O_3 (ppm)		Number of Days Exceeding Standard		
	1-hour	8-hour	State 1-hour	Federal 1-hour	Federal 8-hour
2001	0.093	0.070	0	0	0
2000	0.082	0.068	0	0	0
1999	0.090	0.070	0	0	0
1998	0.091	0.081	0	0	0
1997	0.108	0.086	2	0	1
1996	0.126	0.086	10	1	5
1995	0.118	0.079	4	0	4
1994	0.101		3	0	1
1993	0.143	0.086	5	2	2
1992	0.110	0.086	4	0	4
1991	0.130	0.089	12	2	5
1990	0.110	0.088	5	0	1
1989	0.230	0.094	14	2	10
1988	0.140	0.093	9	1	8
1987	0.180	0.096	20	4	16
1986	0.140	0.098	18	1	6
1985	0.170	0.102	10	3	6
1984	0.190	0.103	13	3	9

Sources of data: California Air Resources Board 2002
USEPA 2002

Table 4.1-4. Ozone Trends Summary: South Central Coast Air Basin

Year	Days > Standard			1-Hour Observations		8-Hour Averages	
	1-Hour State	1-Hour Nat'l	8-Hour Nat'l	Maximum	3-Year 4th High	Maximum	3-Year Average 4th High
2002	23	1	16	0.132	0.124	0.109	0.097
2001	34	2	25	0.129	0.128	0.113	0.101
2000	38	2	30	0.128	0.132	0.108	0.105
1999	33	2	24	0.135	0.134	0.112	0.106
1998	54	6	41	0.174	0.144	0.151	0.112
1997	59	3	46	0.137	0.152	0.114	0.115
1996	82	19	68	0.158	0.158	0.127	0.119
1995	95	25	70	0.169	0.157	0.144	0.117
1994	90	17	65	0.164	0.146	0.132	0.112
1993	63	14	53	0.146	0.15	0.129	0.115
1992	75	12	63	0.15	0.15	0.125	0.118
1991	112	35	94	0.17	0.17	0.14	0.127

Notes:
All concentrations expressed as parts per million.
An exceedance is not necessarily a violation.
Sources of data: California Air Resources Board 2002

Table 4.1-5. Background Air Pollution Data Summary for Nitrogen Dioxide (NO2), El Rio-Rio Mesa School/Ventura (Monitor ID 061113001-1)

Year	Highest 1-hour Concentration for NO_2 (ppm)	Number of Days Exceeding Federal and State Standard	Annual Mean for NO_2 (ppm)
1997	0.072	0	0.014
1998	0.088	0	0.013
1999	0.099	0	0.014
2000	0.074	0	0.014
2001	0.068	0	0.012
2002	0.041	0	0.010

Source of data: USEPA 2002

Table 4.1-6. Background Air Pollution Data Summary for Nitrogen Dioxide (NO2), Ventura Emma Wood State Beach/Ventura (Monitor ID 061112003-1)

Year	Highest 1-hour Concentration for NO_2 (ppm)	Number of Days Exceeding Federal and State Standard	Annual Mean for NO_2 (ppm)
1997	0.069	0	0.011
1998	0.088	0	0.009
1999	0.082	0	0.010
2000	0.065	0	0.011
2001	0.080	0	0.009
2002	0.048	0	0.009

Source of data: USEPA 2002

Table 4.1-7. Background Air Pollution Data Summary for Nitrogen Dioxide (NO2), Oak View/Ventura (Monitor ID 061110005-1)

Year	Highest 1-hour Concentration for NO_2 (ppm)	Number of Days Exceeding Federal and State Standard	Annual Mean for NO_2 (ppm)
1997	0.047	0	0.005
1998	0.062	0	0.004
1999	0.062	0	0.005
2000	0.081	0	0.005
2001	0.058	0	0.004
2002	0.035	0	0.004

Source of data: USEPA 2002

Table 4.1-8. Background Air Pollution Data Summary for Carbon Monoxide (CO), Ventura Monitor ID 061112002-1

Year	Highest 1-hour Concentration for CO (ppm)	Number of Days Exceeding 1-hour Federal (Standard)	Highest 8-hour Concentration for CO (ppm)	Number of Days Exceeding 8-hour Federal (Standard)
1997	7.4	0	3.8	0
1998	7.2	0	3.5	0
1999	6.8	0	3.6	0
2000	6.2	0	4.3	0
2001	4.4	0	3.4	0
2002	5.7	0	2.3	0

Source of data: USEPA 2002

Table 4.1-9. Background Air Pollution Data Summary for Carbon Monoxide (CO), El Rio-Rio Mesa School, El Rio/Ventura Monitor ID 061113001-1

Year	Highest 1-hour Concentration for CO (ppm)	Number of Days Exceeding 1-hour Federal (Standard)	Highest 8-hour Concentration for CO (ppm)	Number of Days Exceeding 8-hour Federal (Standard)
1997	2.6	0	1.5	0
1998	3.7	0	1.6	0
1999	2.4	0	1.2	0
2000	2.1	0	1.2	0
2001	2.3	0	1.3	0
2002	1.7	0	0.9	0

Source of data: USEPA 2002

Table 4.1-10. Background Air Pollution Data Summary for Sulfur Dioxide (SO_2), El Rio-Rio Mesa School El Rio/Ventura (Monitor ID 061113001-1)

Year	Highest 1-hour Concentration for SO_2 (ppm)	Highest 24-hour Concentration for SO_2 (ppm)	Annual Mean for SO_2 (ppm)
1997	0.019	0.011	0.003
1998	0.022	0.012	0.003
1999	0.012	0.006	0.002
2000	0.015	0.009	0.002
2001	0.015	0.009	0.004
2002	0.007	0.003	0.001

Source of data: USEPA 2002

Table 4.1-11. Background Air Pollution Data Summary for PM_{10} at El Rio- Rio Mesa School / #2 Monitor ID 061113001-1

Year	Highest 24-hour Concentration for PM_{10} ($\mu g/m^3$)	Annual Mean for PM_{10} ($\mu g/m^3$)
1997	252	32
1998	70	22
1999	50	27
2000	52	27
2001	51	28
2002	97	29

Source of data: USEPA 2002

Table 4.1-12. PM_{10} Trends Summary: South Central Coast Air Basin

Year	Est. Days>Std.		Annual Averages			
	State	Nat'l	Geometric	Arithmetic	3 -Year Average	Maximum Observation
2002	108	6	24.2	37.5	39	178
2001	138	0	34.9	44.4	35	152
2000	135	0	26.2	33.8	29	113
1999	108	0	28.1	31.3	29	90
1998	88	0	23.8	25.2	30	110
1997	144	14	28.4	37	32	321
1996	138	0	26.2	31.7	30	98
1995	108	0	23.3	39.9	31	129
1994	81	0	26	32.5	31	139
1993	174	0	25.5	42.8	34	141
1992	138	0	28.5	43.1	36	135
1991	204	0	34.3	39.9	39	119

Notes:
All concentrations expressed as micrograms per cubic meter.
An exceedance is not necessarily a violation.
Source: California Air Resources Board 2002

Table 4.1-13. Background Air Pollution Data Summary for Lead at Ventura Monitor ID 06112002-7

Year	Highest 24-Hour Concentration for Lead ($\mu g/m^3$)	Highest Quarterly Mean for Lead ($\mu g/m^3$)	Number of Days Exceeding State and Federal Standard
1997	0.01	0.01	0
1998	0.01	0.01	0
1999	0.06	0.01	0
2000	0.01	0.00	0
2001	0.12	0.02	0
2002	0.02	0.01	0

Source of data: USEPA 2002

5.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

5.1 INTRODUCTION

As stated in Section 4.0, Regulatory Analysis, the proposed facility has the potential to emit criteria pollutants from fuel combustion equipment (generators, SCVs, and diesel-fired equipment) in excess of the PSD significance levels. Therefore, these project emissions are subject to the requirements of the PSD program including a Best Available Control Technology (BACT) analysis. The pollutants subject to PSD permitting are NO_x, CO and VOC since they exceed the PSD significance levels outlined above.

Since the PSD program requires the application of BACT for the control of each regulated pollutant emitted in significant quantities from the proposed site, this section of the permit application addresses the required BACT analysis. For this Project, lean-burn emission controls, SCR, and catalytic oxidation will be used in combination to reduce NO_X , CO, and VOC emissions. This section also summarizes the Project BACT to be installed or utilized to reduce PM_{10} emissions.

5.2 TOP-DOWN BACT APPROACH

Section 165(a)(4) of the Clean Air Act (CAA) and federal regulations contained in 40 CFR 52.21(j) require the owner or operator of a major source or major modification to determine if the proposed construction requires a PSD review. As outlined above, a PSD review is applicable to the proposed Project, and BACT must be applied (EPA, 1990). BACT is defined as *"... an emission limitation, including a visible emission standard, based on the maximum degree of reduction of each pollutant emitted which, on a case by case basis, taking into account energy, environmental, and economic impacts, and other costs, is determined to be achievable through application of production processes and available methods, systems, and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques for control of each such pollutant"* (EPA, 1990).

On December 1, 1987, the EPA Assistant Administrator for Air and Radiation issued a memorandum that implemented certain program initiatives including providing guidance on a "top-down methodology" for determining BACT. The "top-down" process involves the identification of all applicable control technologies according to control effectiveness. The owner or operator then evaluates the "top," or most stringent, control alternative. If the most stringent is shown to be technically or economically infeasible, or if environmental impacts are severe enough to preclude its use, then the next most stringent control technology is similarly evaluated. This process continues until the

BACT level under consideration cannot be eliminated by technical or economic considerations, energy impacts, or environmental impacts.

EPA has consistently interpreted the statutory and regulatory BACT definition as containing two core requirements that EPA believes must be met by any BACT determination, irrespective of whether it is conducted in a "top-down" manner. First, the BACT analysis must include consideration of the most stringent available technologies; i.e., those which provide the "maximum degree of emissions reduction." Second, any decision to require a lesser degree of emissions reduction must be justified by an objective analysis of "energy, environmental, and economic impacts" contained in the record of the permit decisions (EPA, 1990).

The minimum control efficiency to be considered in a BACT analysis must result in an emission rate less than or equal to the New Source Performance Standards (NSPS) emission rate for the source. The applicable NSPS represent the maximum allowable emission limits from the source.

In this BACT analysis, the most effective controls are evaluated based on an analysis of energy, environmental, and economic impacts. As part of the analysis, several control options for potential reductions in criteria pollutants were identified. The control options were identified by three methods: 1) researching the *Reasonably Available Control Technology (RACT) / Best Available Control Technology (BACT) / Lowest Achievable Emission Rate (LAER)* Clearinghouse, 2) drawing upon previous engineering experience, and 3) surveying available literature.

5.2.1 Cost Methodology

Certain BACT alternatives were subjected to an economic analysis to compare capital and annual costs in terms of cost-effectiveness (i.e., dollars per ton of pollutant removed). Capital costs include the initial cost of components intrinsic to the complete control system (SCR, for example, includes catalyst, support frame, urea feed and distribution system, urea storage tanks, piping, rotating equipment, instrumentation, monitoring equipment, and installation costs.) Annual operating costs consist of the financial requirements to operate the control system on an annual basis and include overhead, maintenance, outages, labor, raw materials, and utilities. As outlined below, the Selective Catalytic Reduction (SCR) control technology using ammonia or urea as a reagent represents the only proven and most stringent NO_x control technology for lean burn gas engines and diesel engines. Therefore, since this control technology was selected for this Project, no cost effectiveness data is presented in this BACT analysis.

5.3 BACT FOR NITROGEN OXIDES (NOX)

5.3.1 Formation of NO_x Emissions

NO_x emissions from internal combustion engines (ICE) are a result of two components; thermal processes and fuel constituents. NO_x results from the oxidation of atmospheric nitrogen under high temperature conditions. The amount of NO_x formed is primarily a function of combustion temperature, residence time, and the air/fuel ratio. Fuel NO_x arises from the oxidation of non-elemental nitrogen contained in the fuel. The conversion of fuel-bound nitrogen to NO_x depends on the bound nitrogen content of the fuel. Fuel NO_x formation does not vary appreciably with combustion variables such as temperature or residence time.

Presently, there are no combustion processes or fuel treatment technologies available to control fuel NO_x emissions. NO_x emissions from combustion sources fired with fuel oil are higher than those fired with natural gas due to higher combustion flame temperatures and fuel-bond nitrogen contents. Natural gas typically contains a negligible amount of fuel-bound nitrogen. Therefore, NO_x emissions from natural gas-fueled ICEs are essentially a result of thermal NO_x formation.

5.3.2 Control Technology

The primary front-end combustion controls for ICEs involve controlling the combustion process in the cylinder to minimize NO_x formation. They involve controlling or modifying the combustion that occurs in the cylinder, and include injection / ignition timing retard or air / fuel ratio changes.

Other control methods, known as “back-end” or secondary control methods, remove NO_x from the exhaust gas stream once NO_x has been formed. SCR using ammonia or urea as a reagent represents the only proven NO_x secondary control method for lean burn gas engines and diesel engines (NESCAUM 2000).

The Clearinghouse search summary provided in Appendix D shows that a variety of emission limits and control technologies have been applied to ICEs. The most stringent limits found during a review of EPA’s database were for facilities located in ozone non-attainment areas. These facilities were required to meet such low emission limits since they were subject to Lowest Achievable Emission Rate (LAER) requirements.

Based upon a review of the available NO_x control options, BACT determinations have been proposed for the Project. Table 5-1.1 summarizes the NO_x BACT determinations that resulted from the analysis described in this section.

5.3.3 Selective Catalytic Reduction (SCR)

The following is a review of SCR, the control technology which will be used to control NO_X emissions from the natural gas-fired engines. The almost exclusive use of natural gas for fuel precludes the formation of any significant fuel NO_X. Coincident with CO oxidation, unburned hydrocarbons are also oxidized to lower levels. Diesel fuel emissions will be considerably higher than natural gas emissions, and consequently will be used only during emergencies.

SCR systems reduce NO_X emissions by injecting ammonia (NH_3) or urea as reagents into the exhaust gas stream upstream of a catalyst matrix. NO_x (NO and NO_2), NH_3, and oxygen (O_2) react on the surface of the catalyst to form nitrogen (N_2) and water (H_2O) on a one-to-one molar basis. The exhaust gas must contain a minimum amount of oxygen and be within a particular temperature range (typically 850°F to 1100°F for high-temperature catalysts) in order for the SCR system to operate properly. The temperature range is dictated by the catalyst material, which is typically made from noble metals, including metal oxides such as vanadium pentoxide and titanium dioxide, or zeolite-based material. The removal efficiency of an SCR system in good working order is typically 80 to 90 percent, depending on the amount of catalyst and ammonia used. Exhaust gas temperatures greater than the catalyst's upper temperature limit cause NO_X and NH_3 to pass through the catalyst unreacted.

SCRs will be installed on the power generating ICEs. Ammonia, in the form of dry urea, will be stored onsite and injected into the exhaust stream upstream of the catalyst, after mixing with water available from the vaporization process. The catalyst and catalyst housing used in SCR systems tend to be very large and dense (in terms of surface area to volume ratio) because of the high exhaust flow rates and long residence times required for NO_X, NH_3, and O_2 to react on the catalyst. Most catalysts are configured in parallel-plate or "honeycomb" design to maximize the surface area-to-volume ratio of the catalyst.

Catalyst systems impart significant pressure drops within a gas ICE exhaust system. Static pressure losses in the range of 10 to 12 inches of water column correspond roughly to a 1.0 to 1.2 percent loss in power output and fuel efficiency. Overall efficiency loss is about 1 to 3 percent for dual catalyst systems, depending on aerodynamic design criteria. Also, catalysts are subject to loss of activity over time and require replacement every 5 to 10 years for well operated systems.

SCRs have been used successfully with gas ICEs for years. However, they may cause some adverse environmental impacts. Ammonia gas is toxic in high concentrations and is a hazardous substance that requires special handling and permitting. The unreacted (excess) ammonia goes up the stack as ammonia "slip". In California, ammonia is a listed hazardous air pollutant (HAP) under the Air Toxics 'Hot Spots' Information and Assessment Act of 1987 (AB 2588). As such, ammonia slip in the SCR exhaust will be limited to 10 ppmv in the engine exhaust to prevent public health impacts. Also, the SCR catalyst may contain toxic metals, which must be disposed of as a hazardous waste.

For this Project, requirements for the SCR system include the urea piping and storage system, urea injection controllers, and urea vaporizers and injection grids for each of the three gas engines. SCR will reduce base load exhaust NO_X concentration by 83 percent from 90 ppmv down to 15 ppmv at the stack outlet. Dry urea will be transported by supply boat in a special container and stored on deck in a dry area.

5.3.4 SCV Control Technologies

Currently BACT standards have not been developed for the SCV units. However, as discussed above, the NO_x emissions from the SCV units will be reduced to 40 ppm. Combustion exhaust gas is sparged through a water bath, which is fresh water generated by collection of condensation on cold LNG piping, and from a by-product of combustion exhaust gases vented into the water bath. The water bath is treated with bicarbonate of soda to neutralize the acid from exhaust gases. A detailed review of the SCV regasification process and emission control technology is summarized in Appendix B.

5.4 BACT DETERMINATION FOR CO AND VOC

Catalytic Oxidation of CO and VOC

The following is a review of catalytic oxidation, the control technology which will be used to control thermal CO and VOC from the natural gas-fired engines. Oxidation catalysts are typically used on engines to achieve control of CO emissions. CO catalysts can also reduce VOC and HAP emissions. The catalyst material consists of a precious metal such as platinum, palladium, or rhodium. Other formulations, such as metal oxides for emission streams containing chlorinated compounds, are also used. The CO catalyst promotes the oxidation of CO and hydrocarbon compounds to CO_2 and water (H_2O) as the gas stream passes through the catalyst bed. The oxidation process takes place spontaneously, without the requirement for introducing reactants. The performance of these oxidation catalyst systems on gas engines results in 90 to 95 percent control of CO and 85 to 90 percent control of formaldehyde. Emissions of other organics are also reduced by 60 to 80 percent, depending on the species.

As with SCRs, a CO oxidation catalyst removes pollutants from the engine exhaust gas rather than limiting pollutant formation at the source. Unlike the SCR emission control technology, which requires the use of ammonia as a reducing agent, oxidation catalyst technology does not require the introduction of additional chemicals for the reaction to proceed. Rather, the oxidation of CO to CO_2 utilizes the excess oxygen present in the engine exhaust (typically 15 percent) and the activation energy required for the reaction to proceed is lowered in the presence of the catalyst. Optimum operating temperatures for oxidation catalysts generally fall into the range of 700°F to 1100°F. At lower temperatures, CO conversion efficiency falls off rapidly. Above 1200°F, catalyst sintering may occur, thus causing permanent damage to the catalyst. Operation at part load or during start-up/shut-down will result in less than optimum temperatures and reduced control efficiency.

For this Project, the CO oxidation catalyst will be applied to the Wartsila engines to reduce base load exhaust CO concentration 87 percent from about 54 lb/h to 6.8 pounds per hour. The oxidation catalyst would also reduce VOC emissions approximately 71 percent from about 19 pounds per hour to 5 pounds per hour. Table 5-1.1 summarizes the CO and VOC BACT determinations that resulted from the analysis described in this section.

5.5 SO_X AND PM_{10} CONTROL TECHNOLOGY

Emissions of sulfur oxides (SO_x), composed mainly of SO_2, and PM_{10} are negligible due to the use of natural gas as the primary fuel. Therefore, BACT emission controls are achieved for these pollutants by utilizing natural gas as the primary fuel for the engines and the SCVs.

5.6 DIESEL FUEL CONTROL TECHNOLOGIES

Diesel fuel will be used for the Wartsila dual-fired engine, the back-up emergency generator, the firewater pump, and the freefall life boat in cases of emergencies only and for testing and maintenance of the engines as required by safety and fire regulations.

BACT standards have been established for diesel engines operating as emergency units in several California air quality districts. Standard BACT levels for these types of engines (Reference Appendix D) are as follows: NO_x: 6.9 g/bhp-hr; VOC: 1.0 g/bhp-hr; PM_{10}: 0.38 g/bhp-hr; and CO: 8.5 g/bhp-hr; for emergency engines limited to 200 hours or less of operation per year. The Project diesel-fired engines listed above will meet this standard as outlined in the BACT emission calculations included in Appendix A. In addition, the annual hours of operation for these engines are limited as follows: the emergency generator, firewater pumps, and freefall lifeboat are limited to 200 hours per year, while the Wartsila back-up generator is limited to 100 hours per year on diesel fuel. Therefore, these emergency engines will utilize BACT diesel fuel control technologies.

Table 5-1.1. BACT Determination

Pollutant	Process	Control	Emission Limit
NO_x	I.C. Engine Generators	Selective Catalytic Reduction	0.150 g/BHP-hr
	LNG Vaporizers	Water Bath Sparging	40 ppmv @ 3%
	Emergency Diesel Fired Engines	Manufacturer's Specifications	6.9 g/BHP-hr
CO	I.C. Engines	Catalytic Oxidation	0.200 g/BHP-hr (33 ppmv @ 15%)
	Emergency Diesel Fired Engines	Manufacturer's Specifications	8.5 g/BHP-hr
VOC	I.C. Engines	Catalytic Oxidation	0.150 g/BHP-hr
	Emergency Diesel Fired Engines	Manufacturer's Specifications	1.0 g/BHP-hr
PM_{10}	I.C. Engines	Natural Gas Fuel	0.045 g/BHP-hr
	Emergency Diesel Fired Engines	Manufacturer's Specifications	0.38 g/BHP-hr

6.0 AIR QUALITY IMPACT ANALYSIS

6.1 AIR QUALITY MODELING METHODOLOGY

6.1.1 Model Selection

The air quality impacts of the proposed Project criteria pollutants were estimated through the use of the USEPA-approved Offshore and Coastal Dispersion (OCD) Model. This model is an extension of the classical gaussian plume model, specifically designed to simulate the effects of offshore emissions from point, area, or line sources on the air quality of coastal regions. The model includes special algorithms that account for over-water plume transport and dispersion, as well as changes that take place as the plume crosses the shoreline. The OCD model accounts for offshore downwash, to evaluate the partial penetration of the plume when a temperature inversion is present, and to compute fumigation episodes. It assumes short distances and short time intervals. The OCD model requires a combined data set to complete an over-water analysis, meaning it combines offshore meteorological data with onshore stability class and temperature data.

6.1.2 Onshore Meteorological Data

In this case, the onshore stability class and temperature data came from the Ventura-Emma Wood State Beach monitoring station for the years 1991-1993. The Emma Wood State Beach monitoring station is located off US Route 101, two miles north of Ventura, CA. (longitude-119:18:15, latitude-34:16:50). The VCAPCD provided pre-processed, quality controlled meteorological data sets for this dispersion modeling application. The 1991-1993 data was the only pre-processed, quality controlled data available from the VCAPCD to demonstrate onshore impacts to Ventura County. The VCAPCD provides data in this quality controlled format for the years 1991-1993 for applicants to perform health risk assessments. The VCAPCD requires an air quality data recovery rate of 90 percent for all possible hours for an acceptable monitoring year of data. The 1991-1993 data set meets these requirements. Furthermore, the Emma Wood State Beach monitoring station is the closest meteorological monitoring station to the Project with multiple years of pre-processed data. Therefore, the VCAPCD 1991-1993 onshore data set was selected as the most recent and appropriate onshore data to perform the OCD modeling analysis for this Project.

The Emma Wood monitoring station data obtained from the VCAPCD was imported and parsed into an EXCEL spreadsheet in a Storage and Retrieval of Aerometric Data (SAROAD) format in order to facilitate the input of the data into the OCD model. An algorithm used in EPA-approved pre-processor programs to prepare meteorological data for EPA air models was utilized to determine stability class overland (Pasquill stability categories). This algorithm may be utilized when data for sigma theta (standard deviation of horizontal wind direction variation) is available. The algorithm is a two-tiered process in which an initial estimate of stability class is obtained by identifying the stability class bin that the observed sigma theta value is contained and then modifying this initial estimate by considering time of day and observed wind speed. Nighttime is defined as one hour before sunset to one hour after sunrise. The remaining hours are daytime. Stability classes are categorized from 1 (Stability Class A, very unstable) through 6 (Stability Class F, very stable). In addition, all temperatures from the VCAPCD data set needed to be converted from degrees Celsius to degrees Kelvin in order to accommodate the data requirements of the OCD model.

6.1.3 Offshore Meteorological Data

In order to find the most relevant offshore data sets to use in the OCD model, several offshore monitoring stations were investigated to determine the quality of their data and appropriateness for use for this Project. The VCAPCD was contacted about the monitoring station located on Anacapa Island. This monitoring station provided data from August 1987 through December 1992. The data was sporadic, not pre-processed, and not available electronically. It also did not include all data parameters required by the OCD Model. The SBCAPCD was contacted concerning the monitoring stations located on Santa Rosa Island and Santa Cruz Island. The data from these locations only provided ozone air quality data. The CARB and the Navy (Point Mugu Geophysics Division) were contacted about the availability, nature, and quality of data from the monitoring station on San Nicholas Island. This data was not quality assured or quality controlled, and it did not include all parameters which are required by the OCD Model. Therefore, it was determined that data from offshore buoys was the most relevant for use in the OCD model.

The offshore meteorological data used for the Project was from the National Oceanic Atmospheric Administration (NOAA), Buoy Station 46025 - Santa Monica Basin – 33NM west southwest of Santa Monica, CA, for the years 1991-1993. This data set was most appropriate since it provided parameters necessary for input into the OCD model such as water temperature, over-water wind speed, and over-water wind direction. Data from this time period corresponds with the selected onshore data set. Analysis of the data showed at least a 90 percent recovery rate for all possible hours for each reporting year. A data substitution routine was performed for missing data, since the OCD model cannot be performed if there are any missing data gaps in the data set. There were limited instances where hourly data were missing for more than a few hours. For those instances, the following missing data substitution routine was employed. For the year 1991, two data gaps, one from February 5 to February 15 and one from March 8 to March 29, were replaced with 1993 data from the same time period. This data substitution routine was selected due to the similarities in the 1993 data to the 1991 data for these time periods. For the year 1993, a missing data gap from November 22 to December 23 was replaced with 1992 data from the same time period, also due to similarities in the data. For smaller, hourly data gaps, missing data was replaced with data from the preceding hour.

Buoy data, which is reported in Greenwich Mean Time (GMT), was converted from Pacific Daylight Savings Time (PDT) in order to be combined properly with the onshore data set. In addition, all temperatures from the buoy data set were converted from degrees Celsius to degrees Kelvin in order to accommodate the data requirements of the OCD model. These conversions were executed prior to performing the OCD model runs. A constant relative humidity of 80 percent was assumed for the over-water data analysis. The use of the default humidity percent value is identified in the OCD Model User's Guide (Version 5).

The over-water stability class determination was also performed for the offshore data. The stability classification system for over-water is strictly dependent upon the Monin-Obukhov length and does not apply additional wind speed or time of day cutpoints as used for overland stability. Stability class over water is a function of Monin-Obukhov length according to the following scheme (assuming typical over-water roughness lengths):

<u>L (m.)</u>

$-10 \leq L < 0$

$-25 \leq L < -10$

$[\,L\,] > 25$

$10 < L \leq 25$

$0 < L \leq 10$

The Monin-Obukhov length, in general terms, is the ratio of mechanical turbulence and buoyancy as expressed by the equation below:

$$L = -u^{*3} \times T_v / kg\,Q_{vo}$$

where,
u^* is friction velocity (portion of mechanical turbulence due to wind speed)
T_v is virtual temperature (equivalent temp. of dry air)
k and g are von Karmann and gravitational constants
Q_{vo} is the kinematic virtual heat flux (i.e., indicator of buoyancy)

Therefore, if negative buoyancy is evident and the denominator is of the same order of magnitude as the numerator, an F stability will likely be estimated. Because constant relative humidity was assumed for every hour, the primary factors driving variations in hourly over-water stability for this application were wind speed and the temperature difference between the over-water air and water temperatures.

6.1.4 Quality Control

As mentioned above, the OCD model requires a combination of offshore meteorological data with onshore stability class and temperature data. This data was formatted into an OCD model input file as follows:

- Over-water Stability
- Over-land Stability
- Over-land Wind Direction
- Over-land Wind Speed meters/sec (m/s)
- Over-land Air Temperature (° K)
- Over-water Wind Direction
- Over-water Wind Speed meters/sec (m/s)
- Over-water Air Temperature (° K)
- Over-water Water Temperature (° K)

The following QA/QC checks were run on this final modeling input data:

- Confirmed dry bulb temperature conversion from Celsius to Kelvin from onshore and offshore data EXCEL workbooks to modeling input file.
- Confirmed time shift conversion of onshore and offshore data.
- Confirmed data consistency between EXCEL workbooks and modeling input file for wind speed, wind direction, and dry bulb temperature.
- Confirmed data substitution routines in the offshore data.
- Reviewed stability class determinations for consistency.

Finally, the OCD model was run with the following control options:

- Terrain adjustment;
- Stack tip downwash-switch off;
- Gradual Plume Rise-switch off;
- Buoyancy-induced dispersion;
- Overland met data;
- Land Source;
- Pollutant decay rate via chemical transformation;
- Overland anemometer height;
- Overland wind and terrain; and
- Overland surface roughness length.

Table 6.1-1 lists the release parameters for the Project emission sources, and Table 6.1-2 lists the modeled emission rates for the Project emission sources.

6.2 AIR QUALITY IMPACT ANALYSIS

Results of the atmospheric dispersion modeling are provided in Tables 6.1-3 and 6.1-4, where estimated criteria pollutant concentrations from project emissions are compared to the PSD increments and the NAAQS.

Table 6.1-3 presents estimated maximum impacts relative to PSD Significance Thresholds and Class II Increments. This table indicates that the potential impacts of the Project will be less than PSD Significant Threshold levels for all pollutants and all averaging times, with the exception of the annual NO_2 concentration threshold. However, the estimated annual NO_2 concentrations fall below the PSD Significance Threshold level within 0.2 miles of the FSRU location (more than 14 miles from the nearest shoreline receptor).

For the NAAQS analysis, the highest model-estimated pollutant concentrations at the nearest onshore receptors were added to representative onshore background pollutant concentrations to assess compliance with NAAQS. Background air quality data was collected from the various Ventura County air quality monitoring stations for NO_2, CO, SO_2, and PM_{10}. Table 6.1-4 presents the NAAQS analysis. In all cases, model-estimated concentrations were negligible (i.e. less than PSD Significant Thresholds). Furthermore, modeling results indicated that in no case would an individual NAAQS for any pollutant and averaging time be threatened or exceeded due to Project emissions.

Table 6.1-1. Modeling Release Parameters

Release Parameter	Units	Main Gens	Backup Gen	Vaporizers	Emerg. Pump	Emerg. Gen	Life Boat
Release Height	meters	33	33	35	25	25	1
Release Diameter	meters	1.41	1.00	4.47	0.25	0.66	0.08
Release Velocity	meters/sec	53.4	44.0	2.1	82.1	85.0	85.0
Release Temperature	degrees K	700	700	300	700	700	700

Table 6.1-2. Modeled Emission Rates

Pollutant	Units	Main Gens	Backup Gen	Vaporizers	Emerg. Pump	Emerg. Gen	Life Boat
Nitrogen Oxides (as NO_2)	g/sec	6.04E-01	1.80E-01	1.11E+00	3.52E-02	2.46E-01	1.66E-03
Carbon Monoxide (CO)	g/sec	8.06E-01	2.06E-02	8.45E-01	4.34E-02	3.04E-01	3.03E-04
Sulfur Dioxide (SO_2)	g/sec	1.80E-03	1.25E-04	3.75E-03	2.71E-05	1.90E-04	6.32E-07
Particulates (as PM_{10})	g/sec	1.81E-01	1.08E-02	1.14E-01	1.94E-03	1.36E-02	9.94E-05

Table 6.1-3. PSD Significant Threshold and Increment Analysis

Pollutant	Averaging Period	Maximum Modeled Impact (μg/m3)	Federal PSD Significance Threshold (μg/m3)	Federal PSD Class II Increment (μg/m3)	Maximum Impact Distance From Vessel	
					Distance (m)	Direction (Sector)
CO	1-hr	31.03	2,000	----	825	SSE
CO	8-hr	15.80	500	----	413	N
SO_2	1-hr	----	25	----	-----	-----
SO_2	3-hr	0.10	----	512	633	NNE
SO_2	24-hr	0.04	5	91	608	ENE
SO_2	Annual	0.01	1.0	20	728	E
PM_{10}	24-hr	1.15	5	30	707	E
PM_{10}	Annual	0.16	1.0	17	700	E
NO_2	1-hr	40.87	----	----	825	SSE
NO_2	Annual	1.58	1.0	25	707	E

Notes: μg/m^3 = microgram per cubic meter; PSD = Prevention of Significant Deterioration; m = meters

Table 6.1-4. NAAQS Analysis (Nearest Onshore Receptor)

Pollutant	Averaging Period	Maximum Modeled Impact (μg/m3)	Background Concentration (μg/m3)	Total Impact (μg/m3)	State Standard (μg/m3)	Federal Standard (μg/m3)
CO	1-hr	2.99	8,469	8,472	23,000	40,000
CO	8-hr	0.58	4,921	4,922	10,000	10,000
SO_2	1-hr	-----	58	58	655	-----
SO_2	3-hr	<0.01	-----	-----	-----	1,300
SO_2	24-hr	<0.01	31	31	105	365
SO_2	Annual	<0.01	10	10	-----	80
PM_{10}	24-hr	0.04	97	97	50	150
PM_{10}	Annual	<0.01	29	29	30	50
NO_2	1-hr	3.02	186	189	470	-----
NO_2	Annual	0.01	26	26	-----	100

Notes: μg/m^3 = microgram per cubic meter; NAAQS = National Ambient Air Quality Standard

7.0 ADDITIONAL IMPACT ANALYSIS

7.1 INTRODUCTION

As part of a PSD application a facility must demonstrate that the proposed project will not have a significant impact on ambient air quality, soils and vegetation, visibility, or the potential for future commercial growth. The following additional impacts analyses are required under 40 CFR 52.21(o):

1. Impairment to visibility, soils, and vegetation that would result from the source.
2. General commercial, residential, industrial and other growth associated with the source.
3. Air quality impact of the area as a result of the general growth associated with the source.
4. Air quality impact on nearest Class I areas.
5. Impact on endangered species.

This PSD analysis addresses Air Quality Related Values (AQRVs) in three Class I wilderness areas: Cucamonga, San Gabriel, and San Rafael. AQRVs include terrestrial and aquatic resources (water quality and biota) and are specific to each Class I area. AQRVs also include deposition and visibility-related values. Scientists at the USFS have identified AQRVs and defined limits of acceptable change (LAC) for sensitive receptors within each of the Class I wilderness areas. A determination of their relative susceptibility to air pollutant impacts and the quantity of pollutants which would exceed the LAC has been made. The effects of sulfur and nitrogen deposition, ozone exposure, and particulates causing visibility impacts have also been defined. Specific AQRVs addressed in this section include deposition to estimate impacts on soils and vegetation, and visibility. The USFS has developed guidelines to define AQRVs and to provide for effective impact assessment methods. These guidelines have been used in preparing the assessments presented below.

7.2 VISIBILITY ANALYSIS

Under the PSD Program, Class I areas are assigned to protect Federal wilderness areas, such as national parks, where the least amount of air quality deterioration is allowed. Class I areas are designated as pristine natural areas or areas of natural significance. The Class II designation is used for all others areas, except Class III designations are intended for heavily industrialized zones (40 CFR 51.166). Each classification differs in terms of the amount of growth allowed before significant deterioration of air quality occurs.

The closest Class I areas to the Project are the Cucamonga Wilderness Area and the San Gabriel Wilderness Area located in the San Gabriel Mountains, which are over 62 miles east of Ventura County, near San Bernardino County, and the San Rafael Wilderness Area, located in eastern Santa Barbara County, which is over 63 miles northwest from the Project. Sources located within a distance of 100 km (62 miles) are subject to a visibility impacts. Table 7.2-1 summarizes distances from the Project to these Class I areas.

Table 7.2-1. Distance of Project to Class I Areas

Class 1 Wilderness Area	Closest Distance to FSRU (miles)	Furthest Distance to FSRU (miles)	Closest Distance to FSRU (Km)	Furthest Distance to FSRU (Km)
San Rafael	63.7	97.7	102.5	157.2
San Gabriel	67.0	77.0	107.8	123.9
Cucamonga	83.0	89.0	133.6	143.2

Although these Class I areas are located beyond the 100 km applicability level, a Level 1 visibility screening analysis was conducted to assess the impact of the Project's emissions on visibility at the three Class I Wilderness Areas listed above. The EPA program VISCREEN (Version 1.01) was used. The methodology, input parameters, and model predictions are discussed below.

Visual plume impacts were assessed with VISCREEN as recommended by the EPA *Workbook for Plume Visual Impact Screening and Analysis.* This analysis estimates the presence of a visible plume to a hypothetical observer who is located at the closest boundary of the wilderness areas.

VISCREEN uses two scattering angles to calculate potential plume visual impacts for cases where the plume is likely to be brightest (10 degrees azimuth for the forward scatter case) and darkest (140 degrees azimuth for the backward scatter case). The forward scatter case yields very bright plumes because the sun is placed nearly directly in front of the observer, which would tend to maximize the light scattered by the plume. The backward scatter case yields the darkest possible plumes as the sun is placed directly behind the observer. For terrain viewing backgrounds, the terrain is assumed to be dark and located as close to the observer and the plume as possible. Scattering of green light is assumed (wavelength = 0.55 μm) since the eye is most sensitive to intensity changes in green. The observer is a hypothetical person at the boundary of each wilderness area located closest to the project. The following background visual ranges were assumed:

- Cucamonga Wilderness: **246.4 km**
- San Gabriel Wilderness: **246.4 km**
- San Rafael Wilderness: **243.3 km**

The VISCREEN analysis provides two measures of potential plume impacts. The first measure is plume contrast, which is the relative difference in light intensity between light scattered from the plume and light scattered from the background. This is caused by the same phenomena as discussed in the regional haze analyses described above; that is, the relative difference in the light extinction coefficient between viewing light against background and against the plume.

VISCREEN also provides a second measure of plume perceptibility, the total color contrast (ΔE), since plume perceptibility is a function of both brightness and color. This supplements the first contrast measure with contrast calculated from an integrated function of light wavelengths for the three primary colors in the visible light spectrum: red, green, and blue. Green is used in the brightness component of the calculation; a ratio of red to green light is used for the color or “hue” that is reflected; and a ratio of green to blue light is used as the measure of the strength or density of the color (often called the “saturation”).

The U.S. EPA visibility workbook suggests significance criteria for contrast and perception. The Level-1 screening analysis, which uses the worst-case meteorological conditions of stability class F and a 1.0 m/s wind speed, estimated that potential changes in contrast and perception would not exceed the screening criteria for the three Class I wilderness areas mentioned above. The results of the Level-1 screening analysis for all three areas are provided in Appendix E. Because the Level-1 screening analysis indicated impacts would not exceed the screening criteria, a Level-2 screening analysis was not required.

7.3 GROWTH ANALYSIS

The growth analysis is intended to review the potential impact that the project will have on industrial growth and associated secondary emissions in the vicinity of the Project. Secondary emissions are those which can occur as a result of the project or operation of the facility, but are not emissions from the facility itself. It is not anticipated that the operation of the Terminal will result in excess secondary emissions during the general operation of the facility. Though marine traffic will increase, it is not anticipated that this traffic will cause an excessive amount of emissions from diesel exhaust.

Following construction of the Project, industrial growth is not expected to increase significantly in the area. The onshore facilities consist only of the pipeline connection where the Project pipeline will connect with the SoCalGas system and the addition of an odorant station. The landfall will be at an existing SoCalGas facility. Therefore, no significant growth impacts will result from these onshore installations.

The operation of the Terminal will require approximately 29 employees. Crew will be rotated every 7 days and transferred by boat. The local crew boat embarking and debarking location at Port Hueneme already has sufficient docking and parking facilities in place to provide for these crew transfers. Therefore, the Port Hueneme facility and the surrounding vicinity will not experience any potential growth impacts from the project.

7.4 SOIL AND VEGETATION ANALYSIS

An analysis of the effect of the Project on surrounding soils and vegetation is required of PSD applicants. Only the effects on vegetation of significant commercial value must be evaluated. EPA has stated that: "*For most types of soils and vegetation, ambient concentrations of criteria pollutants below the secondary national ambient air quality standards (NAAQS) will not result in harmful effects* (EPA, 1990)." Since the modeling results show that the project will not result in any ambient concentrations above the monitoring significance levels or NAAQS, no adverse impacts are expected from the Project on soils or vegetation.

The three designated Wilderness Areas contain vegetative ecosystems as identified by the FLM. For each ecosystem, sensitive species or groups of species have also been designated. These species are impacted primarily by ozone but are also impacted by nitrogen and sulfur compounds.

Exposure to ozone can produce several quantifiable effects, including visible injury. Sensitivity to ozone and other stresses varies because of differences in uptake and genetic factors. Lichens are also sensitive receptors for air pollutants. Lichens grow slowly and can live for centuries, and serve as an indicator of the cumulative effects of exposure to air pollution. Based upon the modeling results summarized in Section 6 of this application, the Project would not have any adverse impact on ozone levels, and associated vegetation injury, in the San Gabriel, San Rafael, and Cucamonga Wilderness Areas.

There are few data available on the effects of sulfur compounds on vegetation and there is a wide range of sensitivities to sulfur compounds. In order to protect sensitive species, the USFS recommends that short-term maximum levels should not exceed 40 to 50 parts per billion (ppb) and annual average concentrations should not exceed 8 to12 ppb. Given the very low level of sulfur dioxide emissions from the Project, there would not be an impact at the San Gabriel, San Rafael, or Cucamonga Wilderness Areas.

Based on information presented by the USFS, the San Gabriel, San Rafael, and Cucamonga Wilderness areas have an AQRV associated with aquatic resources (streams and rivers only). NO_x and SO_2 emissions can affect aquatic resources through nitrogen and sulfur deposition. Acid neutralizing capacity (ANC), or alkalinity levels, can be used to measure a lake's ability to absorb nitrogen and sulfur deposition and withstand acidification. Several factors influence ANC, such as bedrock geology, the degree of soil weathering, watershed size, and hydraulic detention. The higher the ANC, the more resistant the water is to acidification. If nitrogen and sulfur deposition exceeds the ANC, or the buffering capacity of a lake, then the ANC is diminished, pH drops, and acidification may occur.

Another potential impact associated with nitrogen deposition is increased algae and plant growth due to the added nitrogen. In some cases, the increased growth leads to lake eutrophication, where introduced nitrogen acts as fertilizer and causes algae blooms. After dense algal mats cover a lake surface, subsurface algae die and cause oxygen deprivation during decay. The results are stressed aquatic resources and potential fish kills.

Since increased nitrogen and sulfur deposition due to the Project will be minimal, impacts to stream and river ANC and pH, and therefore acidification or eutrophication, are not likely to occur at the three designated Class I Areas.

7.5 IMPACTS ON THREATENED AND ENDANGERED SPECIES

Since the modeling analysis predicted that ambient concentrations in the vicinity of the Project would not exceed any of the significance levels or primary and secondary NAAQS, it is expected that this project will not have a significant impact on threatened or endangered species.

Noise levels, lighting, and traffic resulting from both construction and operation of the Project are not expected to significantly exceed current background levels. The Project will use horizontal directional drilling (HDD) in lieu of marine-to-shore trenching for construction in order to minimize environmental impacts, including disruption of habitat for endangered shore birds. Grading and excavation will be limited to the HDD staging area at the SoCalGas tie-in, an existing industrial area. A worker Environmental Awareness Program and a Biological Resources Mitigation Implementation and Monitoring Plan will support avoidance of and minimize disruption to special status species. A SPCC Plan will also minimize the potential for fuel and lube oil spills from construction and transportation vessels associated with the Project. An accidental release of LNG will not affect onshore biotic resources in the Project area because of the distance to the FSRU. No significant impacts to onshore biological resources are, therefore, expected during both construction and operation of the Project.

Although few impacts on marine birds, invertebrates and fish are expected from the Project, more susceptible marine mammals and sea turtles could be affected in the highly unlikely event of a release of LNG, fuel, or lubricating oils from the FSRU or shuttle tankers. Additional impacts could result from construction activities or contact of a Project vessel or mooring line with a marine mammal or turtle.

Several measures will be taken by BHPB to avoid or mitigate any potential impacts to any marine wildlife, in particular marine mammals, and turtles. A marine mammal observer and monitor will be aboard all construction vessels during times that marine mammals are likely to be present in the Project area. Additional SPCC plans and marine mammal contingency plans will be developed to avoid LNG, fuel, or oil spills and effects to marine mammals and turtles. BHPB will consult with U.S. Fish and Wildlife Service, National Marine Fisheries Service, Minerals Management Service, and/or California Department of Fish and Game to ensure these measures are sufficient.

7.6 CONCLUSION

Based upon the data presented in this section of the application, it is concluded that the proposed construction and operation of the Project will not have an adverse impact on the surrounding area. An Environmental Analysis (EA) has been submitted to the USCG. This EA is a comprehensive environmental review of the Project that satisfies the requirements and guidelines of the Deepwater Port Act (DWPA), as well as the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). It is intended for use by the lead Federal and state agencies in determining the potential environmental consequences of Project approval.

8.0 REFERENCES

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APPENDIX A

REGULATED AIR POLLUTANT EMISSIONS CALCULATIONS

Construction Operations Emissions Summary

Table 1. Estimated Daily Construction Emissions

Phase	NO_X	SO_X	CO	PM_{10}	VOC
	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Mooring	3,366	47	744	117	235
Offshore Pipelay	14,527	203	3,209	507	1,013
Onshore Pipelay	1,337	19	295	47	93

Table 2. Estimated Project Construction Emissions

Phase	NO_X	SO_X	CO	PM_{10}	VOC
	tons	tons	tons	tons	tons
Mooring	75.7	1.1	16.7	2.6	5.3
Offshore Pipelay	326.8	4.6	72.2	11.4	22.8
Onshore Pipelay	30.1	0.4	6.6	1.0	2.1

Mooring

Equipment Type	Number of Devices	Engine Rating BHP Each	Operation hrs/day	Average Load	Working Days	Power Output bhp-hr/day	NOX lbs/day	SOX lbs/day	CO lbs/day	PM10 lbs/day	ROC lbs/day	NOX lbs	SOX lbs	CO lbs	PM10 lbs	ROC lbs
AHTS Mains	1	10,750	12	35%	45	45150	1046.60	14.60	231.23	36.51	73.02	47,097	657	10,405	1,643	3,286
AHTS Bow Thruster	1	1,000	2	80%	45	1600	37.09	0.52	8.19	1.29	2.59	1,669	23	369	58	116
AHTS Generators	1	250	12	50%	45	1500	34.77	0.49	7.68	1.21	2.43	1,565	22	346	55	109
AHTS Mains	1	13,750	12	35%	45	57750	1338.68	18.68	295.75	46.70	93.40	60,241	841	13,309	2,101	4,203
AHTS Bow Thruster	1	1,000	2	80%	45	1600	37.09	0.52	8.19	1.29	2.59	1,669	23	369	58	116
AHTS Generators	1	250	12	50%	45	1500	34.77	0.49	7.68	1.21	2.43	1,565	22	346	55	109
Supply Boat Mains	2	3,750	12	35%	45	31500	730.19	10.19	161.32	25.47	50.94	32,858	458	7,259	1,146	2,292
Supply Boat Bow Thruster	2	500	2	80%	45	1600	37.09	0.52	8.19	1.29	2.59	1,669	23	369	58	116
Supply Boat Generators	2	250	12	50%	45	3000	69.54	0.97	15.36	2.43	4.85	3,129	44	691	109	218
TOTAL EMISSIONS, lbs							**3,366**	**47**	**744**	**117**	**235**	**151,462**	**2,113**	**33,463**	**5,284**	**10,567**
TOTAL EMISSIONS, tons												**75.7**	**1.1**	**16.7**	**2.6**	**5.3**

Emission Factors	Units	NOX	SOX	CO	PM10	ROC	Reference
Diesel	lb/BHP-hr	0.0232	0.0003	0.0051	0.0008	0.0016	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency, 0.05% S
Gasoline	lb/BHP-hr	0.0062	0.0003	0.2350	0.0003	0.0089	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency
Truck	grams/mile	13.050		1.390	0.280	0.480	CARB EMFAC 2001 (70 F, 50% RH, non-enhanced I/M, 35 mph)

Mooring Assumptions

1x AHTS @ 12,000 Hp
1x AHTS @ 15,000 Hp
2x Supply vessels @ 4,500 Hp each
2x Barges to transport anchors and equipment (not powered)

Offshore Pipelay

Equipment Type	Number of Devices	Engine Rating BHP Each	Operation hrs/day	Average Load	Working Days	Power Output bhp-hr/day	NOX lbs/day	SOX lbs/day	CO lbs/day	PM10 lbs/day	ROC lbs/day	NOX lbs	SOX lbs	CO lbs	PM10 lbs
Small Drilling Rig (offshore)	1	400	24	80%	45	7680	178.03	2.48	39.33	6.21	12.42	8,011	112	1,770	279
Light Towers	4	20	12	100%	45	960	22.25	0.31	4.92	0.78	1.55	1,001	14	221	35
Welding Generator	4	50	2	50%	45	200	4.64	0.06	1.02	0.16	0.32	209	3	46	7
Lorelay Pipe Ship	1	22,721	24	100%	45	545310	12640.60	176.38	2792.69	440.95	881.90	568,827	7,937	125,671	19,843
Supply Boat Mains	4	3,750	12	35%	45	63000	1460.38	20.38	322.64	50.94	101.89	65,717	917	14,519	2,292
Supply Boat Bow Thruster	4	500	2	80%	45	3200	74.18	1.04	16.39	2.59	5.18	3,338	47	737	116
Supply Boat Generators	4	250	12	50%	45	6000	139.08	1.94	30.73	4.85	9.70	6,259	87	1,383	218
Welding Generator	4	50	2	80%	45	320	7.42	0.10	1.64	0.26	0.52	334	5	74	12
TOTAL EMISSIONS, lbs							**14,527**	**203**	**3,209**	**507**	**1,013**	**653,696**	**9,121**	**144,421**	**22,803**

TOTAL EMISSIONS, tons		**326.8**	**4.6**	**72.2**	**11.4**

Emission Factors	Units	NOX	SOX	CO	PM10	ROC	Reference
Diesel	lb/BHP-hr	0.0232	0.0003	0.0051	0.0008	0.0016	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency, 0.05% S
Gasoline	lb/BHP-hr	0.0062	0.0003	0.2350	0.0003	0.0089	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency
Truck	grams/mile	13.050		1.390	0.280	0.480	CARB EMFAC 2001 (70 F, 50% RH, non-enhanced I/M, 35 mph)

Pipelay Assumptions

1x Small Drilling Rig (offshore) with auxiliaries, 400 Hp
4x Light towers, 20 Hp each
1x Dynamically positioned pipelay vessel "Lorelay", average Hp
4x Supply vessels @ 4,500 Hp each
4x Pipe barges to transport pipe and material offshore (not powered)
4x Diesel welding generators, 50 Hp each

Lorelay Pipe Ship	Qty	Each KW	All KW	Avg Load	Total KW	Total HP
Bow Thruster, tunnel	2	2,600	5,200	35%	1,820	2,441
Bow Thruster, retractable	1	3,000	3,000	35%	1,050	1,408
Stern Thruster, propeller	1	6,000	6,000	35%	2,100	2,816
Stern Thruster, azimuth	2	3,000	6,000	35%	2,100	2,816
Stern Thruster, tunnel	1	1,000	1,000	35%	350	469
Generator Capacity, total	1	19,047	19,047	50%	9,524	12,771
					16,944	22,721

Offshore Pipelay

ROC
lbs
559
70
15
39,686
4,585
233
437
23
45,607

22.8

Onshore Pipelay

Equipment Type	Number of Devices	Engine Rating BHP Each	Operation hrs/day	Average Load	Working Days	Power Output bhp-hr/day	NOX lbs/day	SOX lbs/day	CO lbs/day	PM10 lbs/day	ROC lbs/day	NOX lbs	SOX lbs	CO lbs	PM10 lbs	ROC lbs
Large Drilling Rig (onshore)	2	500	24	80%	45	19200	445.07	6.21	98.33	15.53	31.05	20,028	279	4,425	699	1,397
Mud Cleaner Generator	1	400	24	80%	45	7680	178.03	2.48	39.33	6.21	12.42	8,011	112	1,770	279	559
Mud Pumps	2	500	24	80%	45	19200	445.07	6.21	98.33	15.53	31.05	20,028	279	4,425	699	1,397
Fluid Handling Pumps	4	75	24	80%	45	5760	133.52	1.86	29.50	4.66	9.32	6,008	84	1,327	210	419
Track Backhoe	1	200	12	50%	45	1200	27.82	0.39	6.15	0.97	1.94	1,252	17	277	44	87
All Terrain Forklift	1	100	12	50%	45	600	13.91	0.19	3.07	0.49	0.97	626	9	138	22	44
Light Towers	6	20	12	100%	45	1440	33.38	0.47	7.37	1.16	2.33	1,502	21	332	52	105
18 Wheeler Truck (mi/day)	120				45		3.45	0.00	0.37	0.07	0.13	155	-	17	3	6
Welding Generator	6	50	2	80%	45	480	11.13	0.16	2.46	0.39	0.78	501	7	111	17	35
Large Crane (100 ton)	2	200	6	50%	45	1200	27.82	0.39	6.15	0.97	1.94	1,252	17	277	44	87
Small Crane (35 ton)	2	130	6	50%	45	780	18.08	0.25	3.99	0.63	1.26	814	11	180	28	57
TOTAL EMISSIONS, lbs							**1,337**	**19**	**295**	**47**	**93**	**60,177**	**838**	**13,277**	**2,097**	**4,193**
TOTAL EMISSIONS, tons												**30.1**	**0.4**	**6.6**	**1.0**	**2.1**

Emission Factors	Units	NOX	SOX	CO	PM10	ROC	Reference
Diesel	lb/BHP-hr	0.0232	0.0003	0.0051	0.0008	0.0016	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency, 0.05% S
Gasoline	lb/BHP-hr	0.0062	0.0003	0.2350	0.0003	0.0089	SCAQMD CEQA Air Quality Handbook, Table A9-3-A, 37.1% efficiency
Truck	grams/mile	13.050		1.390	0.280	0.480	CARB EMFAC 2001 (70 F, 50% RH, non-enhanced I/M, 35 mph)

Pipelay Assumptions

1x Large drilling rig (onshore) with auxiliaries, 2700 total Hp
1x Track backhoe, 200 Hp
1x All terrain forklift, 100 Hp
6x Light towers, 20 Hp each
6x Diesel welding generators, 50 Hp each
2x Cranes (shore side), 100 ton capacity (pipe handling / loading), 200 Hp
2x Cranes (shore side), 35 ton capacity (pipe handling / loading), 130 Hp
2x 18 wheelers each traveling total of 2,700 mi/construction period

FSRU Equipment List

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year							
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2	NH_3	HAPs
3	Wartsila 20V34SG Main Generators	7400 KW	Natural Gas	21.0	21.0	28.0	0.1	6.3	45,291	5.2	8.26
1	Wartsila 18V32DF Backup Generator	6000 KW	Gas / CA Diesel	6.3	0.5	0.7	0.0	0.4	694	0.1	0.06
5	TX Sumberged Combustion Vaporizers	39.75 mmBTU/hr	Natural Gas	38.6	1.4	29.4	0.1	4.0	90,481	-	0.51
2	Emergency Fire Pump / Generator	600 KW / 4200 KW	CA Diesel	9.8	1.4	12.1	0.0	0.5	796	-	0.03
1	Freefall Lifeboat	75 BHP (56 KW)	CA Diesel	0.1	0.0	0.0	0.0	0.0	2	-	0.00
1	Diesel Fuel Storage Tank	145,000 gallons	CA Diesel	-	0.0	-	-	-	-	-	0.00
Total Emissions				**75.7**	**24.3**	**70.2**	**0.2**	**11.2**	**137,263**	**5.2**	**8.85**

Device Notes:
Main generators operating at 100% load for 12,800 total machine hours per year, 2 of 3 devices running at any one time, gas fuel
Backup generator operating at 100% load for 200 machine hours per year, dual fuel, 100 hours on gas, 100 hours on diesel fuel
Vaporizers operating at 100% load for 8,000 machine hours per year each, 5 devices, 40,000 machine hours total, gas fuel
Emergency fire pump and generator operating at 100% load for 200 machine hours each per year, diesel fuel
Life Boat exercising at 100% load for 50 machine hours per year each, 1 device, diesel fuel
Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

FSRU Uncontrolled Summary

EMITTENT NAME	Tons per Year (Uncontrolled)						
	Main Gens	Backup Gen	Vaporizers	Emergency	Life Boat	Diesel Tank	Total
Nitrogen Oxides (as NO_2)	126.1	10.3	38.6	9.8	0.06	-	**184.9**
Reactive Organic Compounds (ROC) as CH_4	73.1	1.2	1.4	1.4	0.00	0.027	**77.1**
Carbon Monoxide (CO)	221.7	1.9	29.4	12.1	0.01	-	**265.1**
Sulfur Dioxide (SO_2)	0.062	0.004	0.130	0.0	0.000	-	**0.20**
Particulates (as PM_{10})	6.3	0.4	4.0	0.5	0.00	-	**11.2**
Carbon Dioxide (CO_2)	45,291	694	90,481	795.6	2.32	-	**137,263**
Ammonia Slip (NH_3)	-	-	-	-	-	-	**-**

EMITTENT NAME	Emission Rates (Uncontrolled)						
	Main Gens	Backup Gen	Backup Gen	Vaporizers	Vaporizers	Emergency	Life Boat
	g/BHP-hr	g/BHP-hr gas	g/BHP-hr D2	ppmv @ 3%	lb/mmBTU	g/BHP-hr	g/BHP-hr
Nitrogen Oxides (as NO_2)	0.900	0.911	10.746	40.0	0.0486	6.90	14.00
Reactive Organic Compounds (ROC) as CH_4	0.522	0.916	0.385	4.1	0.0017	1.00	0.83
Carbon Monoxide (CO)	1.583	1.541	0.607	50.0	0.0370	8.50	2.54
Sulfur Dioxide (SO_2)	0.0004	0.0005	0.0044	0.1	0.0002	0.01	0.01
Particulates (as PM_{10})	0.045	0.045	0.380	0.0034	0.0050	0.38	0.84
Carbon Dioxide (CO_2)	323.469	327.344	454.608	98,000	113.8128	560.64	560.64
Ammonia Slip (NH_3)	-						

Device Notes:
Main generators operating at 100% load for 12,800 total machine hours per year, 2 of 3 devices running at any one time, gas fuel
Backup generator operating at 100% load for 200 machine hours per year, dual fuel, 100 hours on gas, 100 hours on diesel fuel
Vaporizers operating at 100% load for 8,000 machine hours per year each, 5 devices, 40,000 machine hours total, gas fuel
Emergency fire pump and generator operating at 100% load for 200 machine hours each per year, diesel fuel
Life Boat exercising at 100% load for 50 machine hours per year each, 1 device, diesel fuel
Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

FSRU Controlled Summary

EMITTENT NAME	Tons per Year (Controlled)						
	Main Gens	Backup Gen	Vaporizers	Emergency	Life Boat	Diesel Tank	Total
Nitrogen Oxides (as NO_2)	21.0	6.3	38.6	9.8	0.06	-	**75.7**
Reactive Organic Compounds (ROC) as CH_4	21.0	0.5	1.4	1.4	0.00	0.027	**24.3**
Carbon Monoxide (CO)	28.0	0.7	29.4	12.1	0.01	-	**70.2**
Sulfur Dioxide (SO_2)	0.062	0.004	0.130	0.0	0.000	-	**0.20**
Particulates (as PM_{10})	6.3	0.4	4.0	0.5	0.00	-	**11.2**
Carbon Dioxide (CO_2)	45,291	694	90,481	795.6	2.32	-	**137,263**
Ammonia Slip (NH_3)	5.2	0.1	-	-	-	-	**5.2**

EMITTENT NAME	Emission Rates (Controlled)						
	Main Gens	Backup Gen	Backup Gen	Vaporizers	Vaporizers	Emergency	Life Boat
	g/BHP-hr	g/BHP-hr gas	g/BHP-hr D2	ppmv @ 3%	lb/mmBTU	g/BHP-hr	g/BHP-hr
Nitrogen Oxides (as NO_2)	0.150	0.150	6.900	40.0	0.0486	6.90	14.00
Reactive Organic Compounds (ROC) as CH_4	0.150	0.150	0.385	4.1	0.0017	1.00	0.83
Carbon Monoxide (CO)	0.200	0.200	0.607	50.0	0.0370	8.50	2.54
Sulfur Dioxide (SO_2)	0.0004	0.0005	0.0044	0.1	0.0002	0.01	0.01
Particulates (as PM_{10})	0.045	0.045	0.380	0.0034	0.0050	0.38	0.84
Carbon Dioxide (CO_2)	323.469	327.344	454.608	98,000	113.8128	560.64	560.64
Ammonia Slip (NH_3)	0.037						

Device Notes:
Main generators operating at 100% load for 12,800 total machine hours per year, 2 of 3 devices running at any one time, gas fuel
Backup generator operating at 100% load for 200 machine hours per year, dual fuel, 100 hours on gas, 100 hours on diesel fuel
Vaporizers operating at 100% load for 8,000 machine hours per year each, 5 devices, 40,000 machine hours total, gas fuel
Emergency fire pump and generator operating at 100% load for 200 machine hours each per year, diesel fuel
Life Boat exercising at 100% load for 50 machine hours per year each, 1 device, diesel fuel
Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

FSRU Controlled Summary

EMITTENT NAME	Tons per Year (Controlled)						
	Main Gens	Backup Gen	Vaporizers	Emergency	Life Boat	Diesel Tank	Total
Benzene	1.10E-01	1.98E-03	1.65E-03	3.96E-03	1.32E-05	2.39E-05	**0.12**
Formaldehyde	6.07E+00	3.90E-02	5.89E-02	5.01E-03	1.67E-05	0.00E+00	**6.17**
PAHs	6.70E-03	4.30E-05	6.93E-05	3.53E-04	1.18E-06	0.00E+00	**0.01**
Naphthalene	1.85E-02	1.19E-04	4.79E-04	3.60E-04	1.20E-06	0.00E+00	**0.02**
Acetaldehyde	9.61E-01	6.18E-03	2.44E-03	3.26E-03	1.08E-05	0.00E+00	**0.97**
Acrolein	5.91E-01	3.79E-03	2.12E-03	3.93E-04	1.31E-06	0.00E+00	**0.60**
Propylene	0.00E+00	0.00E+00	4.16E-01	1.09E-02	3.65E-05	0.00E+00	**0.43**
Toluene	1.02E-01	1.11E-03	2.67E-03	1.74E-03	5.78E-06	1.31E-04	**0.11**
Xylenes	4.58E-02	6.11E-04	1.55E-02	1.21E-03	4.03E-06	1.14E-04	**0.06**
Ethyl Benzene	9.89E-03	6.34E-05	5.42E-03	0.00E+00	0.00E+00	0.00E+00	**0.02**
Hexane	2.77E-01	1.77E-03	3.61E-03	0.00E+00	0.00E+00	0.00E+00	**0.28**
Butadiene -1,3	6.65E-02	4.26E-04	0.00E+00	1.66E-04	5.52E-07	0.00E+00	**0.07**
Propylene Oxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**-**
Facility Total HAPS	**8.26E+00**	**5.51E-02**	**5.09E-01**	**2.74E-02**	**9.12E-05**	**2.69E-04**	**8.85**

Device Notes:
Main generators operating at 100% load for 12,800 total machine hours per year, 2 of 3 devices running at any one time, gas fuel
Backup generator operating at 100% load for 200 machine hours per year, dual fuel, 100 hours on gas, 100 hours on diesel fuel
Vaporizers operating at 100% load for 8,000 machine hours per year each, 5 devices, 40,000 machine hours total, gas fuel
Emergency fire pump and generator operating at 100% load for 200 machine hours each per year, diesel fuel
Life Boat exercising at 100% load for 50 machine hours per year each, 1 device, diesel fuel
Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

FSRU Uncontrolled Summary

EMITTENT NAME	Tons per Year (Uncontrolled)						
	Main Gens	Backup Gen	Vaporizers	Emergency	Life Boat	Diesel Tank	Total
Benzene	1.69E-01	3.04E-03	1.65E-03	3.96E-03	1.32E-05	2.39E-05	**0.18**
Formaldehyde	2.02E+01	1.30E-01	5.89E-02	5.01E-03	1.67E-05	0.00E+00	**20.43**
PAHs	1.03E-02	6.61E-05	6.93E-05	3.53E-04	1.18E-06	0.00E+00	**0.01**
Naphthalene	2.85E-02	1.83E-04	4.79E-04	3.60E-04	1.20E-06	0.00E+00	**0.03**
Acetaldehyde	3.20E+00	2.06E-02	2.44E-03	3.26E-03	1.08E-05	0.00E+00	**3.23**
Acrolein	1.97E+00	1.26E-02	2.12E-03	3.93E-04	1.31E-06	0.00E+00	**1.99**
Propylene	0.00E+00	7.05E-03	4.16E-01	1.09E-02	3.65E-05	0.00E+00	**0.43**
Toluene	1.56E-01	1.71E-03	2.67E-03	1.74E-03	5.78E-06	1.31E-04	**0.16**
Xylenes	7.05E-02	9.40E-04	1.55E-02	1.21E-03	4.03E-06	1.14E-04	**0.09**
Ethyl Benzene	1.52E-02	9.75E-05	5.42E-03	0.00E+00	0.00E+00	0.00E+00	**0.02**
Hexane	4.25E-01	2.73E-03	3.61E-03	0.00E+00	0.00E+00	0.00E+00	**0.43**
Butadiene -1,3	1.02E-01	6.56E-04	0.00E+00	1.66E-04	5.52E-07	0.00E+00	**0.10**
Propylene Oxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Facility Total HAPS	**2.64E+01**	**1.80E-01**	**5.09E-01**	**2.74E-02**	**9.12E-05**	**2.69E-04**	**27.11**

Device Notes:
Main generators operating at 100% load for 12,800 total machine hours per year, 2 of 3 devices running at any one time, gas fuel
Backup generator operating at 100% load for 200 machine hours per year, dual fuel, 100 hours on gas, 100 hours on diesel fuel
Vaporizers operating at 100% load for 8,000 machine hours per year each, 5 devices, 40,000 machine hours total, gas fuel
Emergency fire pump and generator operating at 100% load for 200 machine hours each per year, diesel fuel
Life Boat exercising at 100% load for 50 machine hours per year each, 1 device, diesel fuel
Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

(2) 20V34SG UNC

SIC	1321	
PROCESS EQPT DESCRIPTION	Natural Gas ICE generator, 7400 KW output, Wartsila 20V34SG, 2 running	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	751.521	
AVERAGE HOURLY PROCESS RATE	0.117425	
MAXIMUM HOURLY PROCESS RATE	0.117425	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	2	
HRS/YEAR	6400	
HEAT RATE	8030	BTU/kw-hr
UNIT RATING	14800	KW
CONVERSION EFFICIENCY	42.50%	
AVERAGE HEAT INPUT	118.84	mmBTU/hr
MAXIMUM HEAT INPUT	118.84	mmBTU/hr

Mode	Heat Rate	
High Eff.	8030	BTU/kw-hr
Low NOx	8280	BTU/kw-hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	90	335.529	252,157	126.08	39.40	39.40	3.63E+00	4.96E+00
Reactive Hydrocarbons (ROC) as CH_4	150	194.509	146,178	73.09	22.84	22.84	2.10E+00	2.88E+00
Carbon Monoxide (CO)	260	590.012	443,406	221.70	69.28	69.28	6.38E+00	8.73E+00
Sulfur Dioxide (SO_2)	0.03	0.166	125	0.06	0.02	0.02	1.80E-03	2.46E-03
Particulates (as PM_{10}) (grains/dscf)	0.0038	16.768	12,601	6.30	1.97	1.97	1.81E-01	2.48E-01
Carbon Dioxide (CO_2)	3.38%	120531.043	90581609.2	45290.80	14153.38	14153.38	1.30E+03	1.78E+03
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	1.208	0.900	126.08	39.40
Reactive Hydrocarbons (ROC) as CH_4	0.700	0.522	73.09	22.84
Carbon Monoxide (CO)	2.123	1.583	221.70	69.28
Sulfur Dioxide (SO_2)	0.0006	0.0004	0.06	0.02
Particulates (as PM_{10}) (grains/dscf)	0.060	0.045	6.30	1.97
Carbon Dioxide (CO_2)	433.772	323.469	45,290.80	14153.38
Ammonia Slip (NH_3)	-	-	-	0.00

(2) 20V34SG UNC

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	4.49E-01	4.49E-01	337.3	0.169	0.053	0.053	4.85E-03	6.64E-03
Formaldehyde	5.39E+01	5.39E+01	40,473.9	20.237	6.324	6.324	5.82E-01	7.97E-01
PAHs	2.74E-02	2.74E-02	20.6	0.010	0.003	0.003	2.97E-04	4.06E-04
Naphthalene	7.59E-02	7.59E-02	57.0	0.029	0.009	0.009	8.20E-04	1.12E-03
Acetaldehyde	8.53E+00	8.53E+00	6,408.4	3.204	1.001	1.001	9.22E-02	1.26E-01
Acrolein	5.24E+00	5.24E+00	3,940.1	1.970	0.616	0.616	5.67E-02	7.76E-02
Propylene	n/a	n/a						
Toluene	4.16E-01	4.16E-01	312.8	0.156	0.049	0.049	4.50E-03	6.16E-03
Xylenes	1.88E-01	1.88E-01	141.0	0.071	0.022	0.022	2.03E-03	2.78E-03
Ethyl Benzene	4.05E-02	4.05E-02	30.4	0.015	0.005	0.005	4.38E-04	5.99E-04
Hexane	1.13E+00	1.13E+00	850.9	0.425	0.133	0.133	1.22E-02	1.68E-02
Butadiene -1,3	2.72E-01	2.72E-01	204.7	0.102	0.032	0.032	2.94E-03	4.03E-03
Propylene Oxide	n/a	n/a						

(2) 20V34SG BACT

SIC	1321	
PROCESS EQPT DESCRIPTION	Natural Gas ICE generator, 7400 KW output, Wartsila 20V34SG, 2 running	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	751.521	
AVERAGE HOURLY PROCESS RATE	0.117425	
MAXIMUM HOURLY PROCESS RATE	0.117425	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	2	
HRS/YEAR	6400	
HEAT RATE	8030	BTU/kw-hr
UNIT RATING	14800	KW
CONVERSION EFFICIENCY	42.50%	
AVERAGE HEAT INPUT	118.84	mmBTU/hr
MAXIMUM HEAT INPUT	118.84	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	15.0	55.893	42,005	21.00	6.56	6.56	6.04E-01	8.27E-01
Reactive Hydrocarbons (ROC) as CH_4	43.1	55.893	42,005	21.00	6.56	6.56	6.04E-01	8.27E-01
Carbon Monoxide (CO)	32.8	74.524	56,006	28.00	8.75	8.75	8.06E-01	1.10E+00
Sulfur Dioxide (SO_2)	0.03	0.166	125	0.06	0.02	0.02	1.80E-03	2.46E-03
Particulates (as PM_{10}) (grains/dscf)	0.0038	16.768	12,601	6.30	1.97	1.97	1.81E-01	2.48E-01
Carbon Dioxide (CO_2)	3.38%	120531.043	90581609.2	45290.80	14153.38	14153.38	1.30E+03	1.78E+03
Ammonia Slip (NH_3)	10	13.778	10,354	5.18	1.62	1.62	1.49E-01	2.04E-01

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	0.201	0.150	21.00	6.56
Reactive Hydrocarbons (ROC) as CH_4	0.201	0.150	21.00	6.56
Carbon Monoxide (CO)	0.268	0.200	28.00	8.75
Sulfur Dioxide (SO_2)	0.0006	0.0004	0.06	0.02
Particulates (as PM_{10}) (grains/dscf)	0.060	0.045	6.30	1.97
Carbon Dioxide (CO_2)	433.772	323.469	45,290.80	14153.38
Ammonia Slip (NH_3)	0.050	0.037	5.18	1.62

(2) 20V34SG BACT

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	4.49E-01	2.92E-01	219.2	0.110	0.034	0.034	3.15E-03	4.32E-03
Formaldehyde	5.39E+01	1.62E+01	12,142.2	6.071	1.897	1.897	1.75E-01	2.39E-01
PAHs	2.74E-02	1.78E-02	13.4	0.007	0.002	0.002	1.93E-04	2.64E-04
Naphthalene	7.59E-02	4.93E-02	37.1	0.019	0.006	0.006	5.33E-04	7.30E-04
Acetaldehyde	8.53E+00	2.56E+00	1,922.5	0.961	0.300	0.300	2.77E-02	3.78E-02
Acrolein	5.24E+00	1.57E+00	1,182.0	0.591	0.185	0.185	1.70E-02	2.33E-02
Propylene	n/a	n/a						
Toluene	4.16E-01	2.71E-01	203.3	0.102	0.032	0.032	2.92E-03	4.00E-03
Xylenes	1.88E-01	1.22E-01	91.7	0.046	0.014	0.014	1.32E-03	1.80E-03
Ethyl Benzene	4.05E-02	2.63E-02	19.8	0.010	0.003	0.003	2.85E-04	3.89E-04
Hexane	1.13E+00	7.36E-01	553.1	0.277	0.086	0.086	7.95E-03	1.09E-02
Butadiene -1,3	2.72E-01	1.77E-01	133.0	0.067	0.021	0.021	1.91E-03	2.62E-03
Propylene Oxide	n/a	n/a						

(2) 20V34SG Reduction

SIC	1321	
PROCESS EQPT DESCRIPTION	Natural Gas ICE generator, 7400 KW output, Wartsila 20V34SG, 2 running	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	751.521	
AVERAGE HOURLY PROCESS RATE	0.117425	
MAXIMUM HOURLY PROCESS RATE	0.117425	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	2	
HRS/YEAR	6400	
HEAT RATE	8030	BTU/kw-hr
UNIT RATING	14800	KW
CONVERSION EFFICIENCY	42.50%	
AVERAGE HEAT INPUT	118.84	mmBTU/hr
MAXIMUM HEAT INPUT	118.84	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)			210,152	105.08	32.84	32.84		
Reactive Hydrocarbons (ROC) as CH_4			104,173	52.09	16.28	16.28		
Carbon Monoxide (CO)			387,400	193.70	60.53	60.53		
Sulfur Dioxide (SO_2)			-	-	-	-		
Particulates (as PM_{10}) (grains/dscf)			-	-	-	-		
Carbon Dioxide (CO_2)			-	-	-	-		
Ammonia Slip (NH_3)			(10,354)	(5.18)	(1.62)	(1.62)		

EMITTENT NAME			AVERAGE PERCENT	AVERAGE PERCENT	AVERAGE PERCENT	MAXIMUM PERCENT		
Nitrogen Oxides (as NO_2)			83%	83%	83%	83%		
Reactive Hydrocarbons (ROC) as CH_4			71%	71%	71%	71%		
Carbon Monoxide (CO)			87%	87%	87%	87%		
Sulfur Dioxide (SO_2)			0%	0%	0%	0%		
Particulates (as PM_{10}) (grains/dscf)			0%	0%	0%	0%		
Carbon Dioxide (CO_2)			0%	0%	0%	0%		
Ammonia Slip (NH_3)			n/a	n/a	n/a	n/a		

Item	18V34SG (2)	Units	Remarks		
NO_X Molecular Weight	31.6	lb/mole	90% NO, 10% NO2		
NO_X, Lean Burn	39.40	lb/hr	uncontrolled	90	ppm Nox
NO_X, SCR	6.56	lb/hr	controlled	15	ppm Nox
Ammonia Slip	1.62	lb/hr	controlled		
NO_X, Lean Burn	1.25	mole/hr	uncontrolled		
NO_X, SCR	0.21	mole/hr	controlled		
Ammonia Slip	0.10	mole/hr	excess		
Ammonia Consumption	1.13	mole/hr	1:1 molar ratio (uncontrolled - controlled + slip)		
Urea Consumption	0.57	moles/hr	$CH_4N_2O + H_2O$ + heat = $2NH_3 + CO_2$		
Urea Consumption (dry)	34.0	lb/hr			
Urea Consumption (dry)	817	lb/day			
Urea Consumption (dry)	5,717	lb/wk	519.3	gal urea	
Maximum Monthly Usage	**24,501**	**lb/mo**	11434	lb water	
			1371	gal water	
			1890.2	gal soln	

18V32DF GAS UNC

SIC	1321	
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, 6000 KW output, Wartsila 18V32DF	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	4.818	
AVERAGE HOURLY PROCESS RATE	0.048175	
MAXIMUM HOURLY PROCESS RATE	0.048175	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	1	
HRS/YEAR	100	
HEAT RATE	8126	BTU/kw-hr
UNIT RATING	6000	KW
CONVERSION EFFICIENCY	42.0%	
AVERAGE HEAT INPUT	48.76	mmBTU/hr
MAXIMUM HEAT INPUT	48.76	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	90	335.529	1,616	0.81	16.16	16.16	2.32E-02	2.04E+00
Reactive Hydrocarbons (ROC) as CH_4	260	337.150	1,624	0.81	16.24	16.24	2.34E-02	2.05E+00
Carbon Monoxide (CO)	250	567.319	2,733	1.37	27.33	27.33	3.93E-02	3.44E+00
Sulfur Dioxide (SO_2)	0.03	0.166	1	0.00	0.01	0.01	1.15E-05	1.01E-03
Particulates (as PM_{10}) (grains/dscf)	0.0037	16.569	80	0.04	0.80	0.80	1.15E-03	1.01E-01
Carbon Dioxide (CO_2)	3.38%	120531.043	580,659	290.33	5806.59	5806.59	8.35E+00	7.32E+02
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	1.222	0.911	0.81	16.16
Reactive Hydrocarbons (ROC) as CH_4	1.228	0.916	0.81	16.24
Carbon Monoxide (CO)	2.066	1.541	1.37	27.33
Sulfur Dioxide (SO_2)	0.0006	0.0005	0.00	0.01
Particulates (as PM_{10}) (grains/dscf)	0.060	0.045	0.04	0.80
Carbon Dioxide (CO_2)	438.968	327.344	290.33	5806.59
Ammonia Slip (NH_3)	-	-	-	0.00

18V32DF GAS UNC

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	4.49E-01	4.49E-01	2.2	0.001	0.022	0.022	3.11E-05	2.72E-03
Formaldehyde	5.39E+01	5.39E+01	259.5	0.130	2.595	2.595	3.73E-03	3.27E-01
PAHs	2.74E-02	2.74E-02	0.1	0.000	0.001	0.001	1.90E-06	1.67E-04
Naphthalene	7.59E-02	7.59E-02	0.4	0.000	0.004	0.004	5.26E-06	4.61E-04
Acetaldehyde	8.53E+00	8.53E+00	41.1	0.021	0.411	0.411	5.91E-04	5.18E-02
Acrolein	5.24E+00	5.24E+00	25.3	0.013	0.253	0.253	3.63E-04	3.18E-02
Propylene	n/a							
Toluene	4.16E-01	4.16E-01	2.0	0.001	0.020	0.020	2.88E-05	2.53E-03
Xylenes	1.88E-01	1.88E-01	0.9	0.000	0.009	0.009	1.30E-05	1.14E-03
Ethyl Benzene	4.05E-02	4.05E-02	0.2	0.000	0.002	0.002	2.81E-06	2.46E-04
Hexane	1.13E+00	1.13E+00	5.5	0.003	0.055	0.055	7.85E-05	6.87E-03
Butadiene -1,3	2.72E-01	2.72E-01	1.3	0.001	0.013	0.013	1.89E-05	1.65E-03
Propylene Oxide	n/a							

18V32DF Diesel UNC

SIC	1321	
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, 6000 KW output, Wartsila 18V32DF	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	36.899	
AVERAGE HOURLY PROCESS RATE	0.3690	
MAXIMUM HOURLY PROCESS RATE	0.3690	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	100	
HEAT RATE	8427	BTU/kw-hr
UNIT RATING	6000	KW
CONVERSION EFFICIENCY	40.5%	
AVERAGE HEAT INPUT	50.56	mmBTU/hr
MAXIMUM HEAT INPUT	50.56	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	970	516.602	19,062	9.53	190.62	190.62	2.74E-01	2.40E+01
Reactive Hydrocarbons (ROC) as CH_4	100	18.524	684	0.34	6.84	6.84	9.83E-03	8.61E-01
Carbon Monoxide (CO)	90	29.176	1,077	0.54	10.77	10.77	1.55E-02	1.36E+00
Sulfur Dioxide (SO_2)	0.29	0.213	8	0.00	0.08	0.08	1.13E-04	9.90E-03
Particulates (as PM_{10}) (grains/dscf)	0.0287	18.268	674	0.34	6.74	6.74	9.70E-03	8.49E-01
Carbon Dioxide (CO_2)	4.29%	21854.275	806,405	403.20	8064.05	8064.05	1.16E+01	1.02E+03
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	14.411	10.746	9.53	190.62
Reactive Hydrocarbons (ROC) as CH_4	0.517	0.385	0.34	6.84
Carbon Monoxide (CO)	0.814	0.607	0.54	10.77
Sulfur Dioxide (SO_2)	0.0059	0.0044	0.00	0.08
Particulates (as PM_{10}) (grains/dscf)	0.510	0.380	0.34	6.74
Carbon Dioxide (CO_2)	609.629	454.608	403.20	8064.05
Ammonia Slip (NH_3)	-	-	-	0.00

18V32DF Diesel UNC

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	1.06E-01	1.06E-01	3.92	0.0020	0.0392	0.0392	5.64E-05	4.94E-03
Formaldehyde	1.08E-02	1.08E-02	0.40	0.0002	0.0040	0.0040	5.74E-06	5.03E-04
PAHs	n/a							
Naphthalene	n/a							
Acetaldehyde	3.45E-03	3.45E-03	0.13	0.0001	0.0013	0.0013	1.83E-06	1.61E-04
Acrolein	1.08E-03	1.08E-03	0.04	0.0000	0.0004	0.0004	5.73E-07	5.02E-05
Propylene	3.82E-01	3.82E-01	14.10	0.0071	0.1410	0.1410	2.03E-04	1.78E-02
Toluene	3.85E-02	3.85E-02	1.42	0.0007	0.0142	0.0142	2.04E-05	1.79E-03
Xylenes	2.64E-02	2.64E-02	0.98	0.0005	0.0098	0.0098	1.40E-05	1.23E-03
Ethyl Benzene	n/a							
Hexane	n/a							
Butadiene -1,3	n/a							
Propylene Oxide	n/a							

18V32DF GAS BACT

SIC	1321	
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, 6000 KW output, Wartsila 18V32DF	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	4.818	
AVERAGE HOURLY PROCESS RATE	0.048175	
MAXIMUM HOURLY PROCESS RATE	0.048175	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	1	
HRS/YEAR	100	
HEAT RATE	8126	BTU/kw-hr
UNIT RATING	6000	KW
CONVERSION EFFICIENCY	42.0%	
AVERAGE HEAT INPUT	48.76	mmBTU/hr
MAXIMUM HEAT INPUT	48.76	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	14.8	55.231	266	0.13	2.66	2.66	3.83E-03	3.35E-01
Reactive Hydrocarbons (ROC) as CH_4	42.6	55.231	266	0.13	2.66	2.66	3.83E-03	3.35E-01
Carbon Monoxide (CO)	32.5	73.642	355	0.18	3.55	3.55	5.10E-03	4.47E-01
Sulfur Dioxide (SO_2)	0.03	0.166	1	0.00	0.01	0.01	1.15E-05	1.01E-03
Particulates (as PM_{10}) (grains/dscf)	0.0037	16.569	80	0.04	0.80	0.80	1.15E-03	1.01E-01
Carbon Dioxide (CO_2)	3.38%	120531.043	580,659	290.33	5806.59	5806.59	8.35E+00	7.32E+02
Ammonia Slip (NH_3)	10	13.778	66	0.03	0.66	0.66	9.55E-04	8.36E-02

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	0.201	0.150	0.13	2.66
Reactive Hydrocarbons (ROC) as CH_4	0.201	0.150	0.13	2.66
Carbon Monoxide (CO)	0.268	0.200	0.18	3.55
Sulfur Dioxide (SO_2)	0.0006	0.0005	0.00	0.01
Particulates (as PM_{10}) (grains/dscf)	0.060	0.045	0.04	0.80
Carbon Dioxide (CO_2)	438.968	327.344	290.33	5806.59
Ammonia Slip (NH_3)	0.050	0.037	0.03	0.66

18V32DF GAS BACT

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	4.49E-01	2.92E-01	1.4	0.001	0.014	0.014	2.02E-05	1.77E-03
Formaldehyde	5.39E+01	1.62E+01	77.8	0.039	0.778	0.778	1.12E-03	9.81E-02
PAHs	2.74E-02	1.78E-02	0.1	0.000	0.001	0.001	1.24E-06	1.08E-04
Naphthalene	7.59E-02	4.93E-02	0.2	0.000	0.002	0.002	3.42E-06	2.99E-04
Acetaldehyde	8.53E+00	2.56E+00	12.3	0.006	0.123	0.123	1.77E-04	1.55E-02
Acrolein	5.24E+00	1.57E+00	7.6	0.004	0.076	0.076	1.09E-04	9.55E-03
Propylene	n/a							
Toluene	4.16E-01	2.71E-01	1.3	0.001	0.013	0.013	1.87E-05	1.64E-03
Xylenes	1.88E-01	1.22E-01	0.6	0.000	0.006	0.006	8.45E-06	7.40E-04
Ethyl Benzene	4.05E-02	2.63E-02	0.1	0.000	0.001	0.001	1.82E-06	1.60E-04
Hexane	1.13E+00	7.36E-01	3.5	0.002	0.035	0.035	5.10E-05	4.47E-03
Butadiene -1,3	2.72E-01	1.77E-01	0.9	0.000	0.009	0.009	1.23E-05	1.07E-03
Propylene Oxide	n/a							

18V32DF Diesel BACT

SIC	1321	
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, 6000 KW output, Wartsila 18V32DF	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	36.899	
AVERAGE HOURLY PROCESS RATE	0.3690	
MAXIMUM HOURLY PROCESS RATE	0.3690	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	100	
HEAT RATE	8427	BTU/kw-hr
UNIT RATING	6000	KW
CONVERSION EFFICIENCY	40.5%	
AVERAGE HEAT INPUT	50.56	mmBTU/hr
MAXIMUM HEAT INPUT	50.56	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	622.82	331.703	12,240	6.12	122.40	122.40	1.76E-01	1.54E+01
Reactive Hydrocarbons (ROC) as CH_4	100.00	18.524	684	0.34	6.84	6.84	9.83E-03	8.61E-01
Carbon Monoxide (CO)	90.00	29.176	1,077	0.54	10.77	10.77	1.55E-02	1.36E+00
Sulfur Dioxide (SO_2)	0.29	0.213	8	0.00	0.08	0.08	1.13E-04	9.90E-03
Particulates (as PM_{10}) (grains/dscf)	0.0287	18.268	674	0.34	6.74	6.74	9.70E-03	8.49E-01
Carbon Dioxide (CO_2)	4.29%	21854.275	806,405	403.20	8064.05	8064.05	1.16E+01	1.02E+03
Ammonia Slip (NH_3)	10	1.968	73	0.04	0.73	0.73	1.04E-03	9.15E-02

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	9.253	6.900	6.12	122.40
Reactive Hydrocarbons (ROC) as CH_4	0.517	0.385	0.34	6.84
Carbon Monoxide (CO)	0.814	0.607	0.54	10.77
Sulfur Dioxide (SO_2)	0.0059	0.0044	0.00	0.08
Particulates (as PM_{10}) (grains/dscf)	0.510	0.380	0.34	6.74
Carbon Dioxide (CO_2)	609.629	454.608	403.20	8064.05
Ammonia Slip (NH_3)	0.055	0.041	0.04	0.73

18V32DF Diesel BACT

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	1.06E-01	6.91E-02	2.55	0.0013	0.0255	0.0255	3.67E-05	3.21E-03
Formaldehyde	1.08E-02	3.24E-03	0.12	0.0001	0.0012	0.0012	1.72E-06	1.51E-04
PAHs	n/a							
Naphthalene	n/a							
Acetaldehyde	3.45E-03	1.04E-03	0.04	0.0000	0.0004	0.0004	5.50E-07	4.82E-05
Acrolein	1.08E-03	3.24E-04	0.01	0.0000	0.0001	0.0001	1.72E-07	1.51E-05
Propylene	3.82E-01							
Toluene	3.85E-02	2.50E-02	0.92	0.0005	0.0092	0.0092	1.33E-05	1.16E-03
Xylenes	2.64E-02	1.72E-02	0.63	0.0003	0.0063	0.0063	9.12E-06	7.99E-04
Ethyl Benzene	n/a							
Hexane	n/a							
Butadiene -1,3	n/a							
Propylene Oxide	n/a							

(5) SCV Controlled

SIC	1321	
PROCESS EQPT DESCRIPTION	Submerged Combustion Vaporizer, TX Burner, 39.75 mmBTU/hr x 5	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	1571.017	
AVERAGE HOURLY PROCESS RATE	0.196377	
MAXIMUM HOURLY PROCESS RATE	0.196377	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	5	
HRS/YEAR	8000	
HEAT RATE	n/a	BTU/kw-hr
UNIT RATING	39.75	mmBTU/hr
CONVERSION EFFICIENCY	n/a	
AVERAGE HEAT INPUT	198.75	mmBTU/hr
MAXIMUM HEAT INPUT	198.75	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	40	49.153	77,220	38.61	9.65	9.65	1.11E+00	1.22E+00
Reactive Hydrocarbons (ROC) as CH_4	4.1	1.752	2,753	1.38	0.34	0.34	3.96E-02	4.34E-02
Carbon Monoxide (CO)	50	37.399	58,754	29.38	7.34	7.34	8.45E-01	9.25E-01
Sulfur Dioxide (SO_2)	0.10	0.166	261	0.13	0.03	0.03	3.75E-03	4.11E-03
Particulates (as PM_{10}) (grains/dscf)	0.0034	5.060	7,950	3.98	0.99	0.99	1.14E-01	1.25E-01
Carbon Dioxide (CO_2)	9.80%	115188.009	180962371	90481.19	22620.30	22620.30	2.60E+03	2.85E+03
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	ppmv	lb/mmbtu	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	40.0	0.0486	38.61	9.65
Reactive Hydrocarbons (ROC) as CH_4	4.1	0.0017	1.38	0.34
Carbon Monoxide (CO)	50.0	0.0370	29.38	7.34
Sulfur Dioxide (SO_2)	0.1	0.0002	0.13	0.03
Particulates (as PM_{10}) (grains/dscf)	0.0034	0.0050	3.98	0.99
Carbon Dioxide (CO_2)	98,000	113.8128	90,481.19	22620.30
Ammonia Slip (NH_3)	-	0.0000	-	0.00

(5) SCV Controlled

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	2.10E-03	2.10E-03	3.30	0.0016	0.0004	0.0004	4.75E-05	5.20E-05
Formaldehyde	7.50E-02	7.50E-02	117.83	0.0589	0.0147	0.0147	1.69E-03	1.86E-03
PAHs	8.82E-05	8.82E-05	0.14	0.0001	0.0000	0.0000	1.99E-06	2.18E-06
Naphthalene	6.10E-04	6.10E-04	0.96	0.0005	0.0001	0.0001	1.38E-05	1.51E-05
Acetaldehyde	3.10E-03	3.10E-03	4.87	0.0024	0.0006	0.0006	7.00E-05	7.67E-05
Acrolein	2.70E-03	2.70E-03	4.24	0.0021	0.0005	0.0005	6.10E-05	6.68E-05
Propylene	5.30E-01	5.30E-01	832.64	0.4163	0.1041	0.1041	1.20E-02	1.31E-02
Toluene	3.40E-03	3.40E-03	5.34	0.0027	0.0007	0.0007	7.68E-05	8.41E-05
Xylenes	1.97E-02	1.97E-02	30.95	0.0155	0.0039	0.0039	4.45E-04	4.87E-04
Ethyl Benzene	6.90E-03	6.90E-03	10.84	0.0054	0.0014	0.0014	1.56E-04	1.71E-04
Hexane	4.60E-03	4.60E-03	7.23	0.0036	0.0009	0.0009	1.04E-04	1.14E-04
Butadiene -1,3	n/a	n/a						
Propylene Oxide	n/a	n/a						

Firewater Pump

SIC	1321	
PROCESS EQPT DESCRIPTION	Firewater Pump, 800 BHP, 600 KW	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	8.851	
AVERAGE HOURLY PROCESS RATE	0.0443	
MAXIMUM HOURLY PROCESS RATE	0.0443	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	200	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	600	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	6.06	mmBTU/hr
MAXIMUM HEAT INPUT	6.06	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	519.32	276.581	2,448	1.22	12.24	12.24	3.52E-02	1.54E+00
Reactive Hydrocarbons (ROC) as CH_4	216.39	40.084	355	0.18	1.77	1.77	5.10E-03	2.24E-01
Carbon Monoxide (CO)	1051.01	340.716	3,016	1.51	15.08	15.08	4.34E-02	1.90E+00
Sulfur Dioxide (SO_2)	0.29	0.213	2	0.00	0.01	0.01	2.71E-05	1.19E-03
Particulates (as PM_{10}) (grains/dscf)	0.0239	15.232	135	0.07	0.67	0.67	1.94E-03	8.49E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	198,899	99.45	994.49	994.49	2.86E+00	1.25E+02
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	9.253	6.900	1.22	12.24
Reactive Hydrocarbons (ROC) as CH_4	1.341	1.000	0.18	1.77
Carbon Monoxide (CO)	11.399	8.500	1.51	15.08
Sulfur Dioxide (SO_2)	0.0071	0.0053	0.00	0.01
Particulates (as PM_{10}) (grains/dscf)	0.510	0.380	0.07	0.67
Carbon Dioxide (CO_2)	751.821	560.642	99.45	994.49
Ammonia Slip (NH_3)	-	-	-	0.00

Firewater Pump

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	1.28E-01	1.28E-01	1.13	0.0006	0.0057	0.0057	1.63E-05	7.13E-04
Formaldehyde	1.62E-01	1.62E-01	1.43	0.0007	0.0072	0.0072	2.06E-05	9.01E-04
PAHs	1.14E-02	1.14E-02	0.10	0.0001	0.0005	0.0005	1.45E-06	6.36E-05
Naphthalene	1.16E-02	1.16E-02	0.10	0.0001	0.0005	0.0005	1.48E-06	6.48E-05
Acetaldehyde	1.05E-01	1.05E-01	0.93	0.0005	0.0047	0.0047	1.34E-05	5.86E-04
Acrolein	1.27E-02	1.27E-02	0.11	0.0001	0.0006	0.0006	1.61E-06	7.07E-05
Propylene	3.53E-01	3.53E-01	3.13	0.0016	0.0156	0.0156	4.50E-05	1.97E-03
Toluene	5.60E-02	5.60E-02	0.50	0.0002	0.0025	0.0025	7.13E-06	3.12E-04
Xylenes	3.90E-02	3.90E-02	0.35	0.0002	0.0017	0.0017	4.97E-06	2.18E-04
Ethyl Benzene	n/a							
Hexane	n/a							
Butadiene -1,3	5.36E-03	5.36E-03	0.05	0.0000	0.0002	0.0002	6.82E-07	2.99E-05
Propylene Oxide	n/a							

Emergency Generator

SIC	1321	
PROCESS EQPT DESCRIPTION	Emergency Generator, 4200 KW	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	61.954	
AVERAGE HOURLY PROCESS RATE	0.3098	
MAXIMUM HOURLY PROCESS RATE	0.3098	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	200	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	4200	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	42.45	mmBTU/hr
MAXIMUM HEAT INPUT	42.45	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	519.32	276.581	17,135	8.57	85.68	85.68	2.46E-01	1.08E+01
Reactive Hydrocarbons (ROC) as CH_4	216.39	40.084	2,483	1.24	12.42	12.42	3.57E-02	1.56E+00
Carbon Monoxide (CO)	1051.01	340.716	21,109	10.55	105.54	105.54	3.04E-01	1.33E+01
Sulfur Dioxide (SO_2)	0.29	0.213	13	0.01	0.07	0.07	1.90E-04	8.31E-03
Particulates (as PM_{10}) (grains/dscf)	0.0239	15.232	944	0.47	4.72	4.72	1.36E-02	5.95E-01
Carbon Dioxide (CO_2)	4.41%	22472.9	1,392,292	696.15	6961.46	6961.46	2.00E+01	8.77E+02
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	9.253	6.900	8.57	85.68
Reactive Hydrocarbons (ROC) as CH_4	1.341	1.000	1.24	12.42
Carbon Monoxide (CO)	11.399	8.500	10.55	105.54
Sulfur Dioxide (SO_2)	0.0071	0.0053	0.01	0.07
Particulates (as PM_{10}) (grains/dscf)	0.510	0.380	0.47	4.72
Carbon Dioxide (CO_2)	751.821	560.642	696.15	6961.46
Ammonia Slip (NH_3)	-	-	-	0.00

Emergency Generator

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	1.28E-01	1.28E-01	7.92	0.0040	0.0396	0.0396	1.14E-04	4.99E-03
Formaldehyde	1.62E-01	1.62E-01	10.02	0.0050	0.0501	0.0501	1.44E-04	6.31E-03
PAHs	1.14E-02	1.14E-02	0.71	0.0004	0.0035	0.0035	1.02E-05	4.45E-04
Naphthalene	1.16E-02	1.16E-02	0.72	0.0004	0.0036	0.0036	1.04E-05	4.53E-04
Acetaldehyde	1.05E-01	1.05E-01	6.51	0.0033	0.0326	0.0326	9.36E-05	4.10E-03
Acrolein	1.27E-02	1.27E-02	0.79	0.0004	0.0039	0.0039	1.13E-05	4.95E-04
Propylene	3.53E-01	3.53E-01	21.90	0.0109	0.1095	0.1095	3.15E-04	1.38E-02
Toluene	5.60E-02	5.60E-02	3.47	0.0017	0.0174	0.0174	4.99E-05	2.19E-03
Xylenes	3.90E-02	3.90E-02	2.42	0.0012	0.0121	0.0121	3.48E-05	1.52E-03
Ethyl Benzene	n/a							
Hexane	n/a							
Butadiene -1,3	5.36E-03	5.36E-03	0.33	0.0002	0.0017	0.0017	4.77E-06	2.09E-04
Propylene Oxide	n/a							

Freefall Lifeboat

SIC	1321	
PROCESS EQPT DESCRIPTION	Freefall Lifeboat Engine, 75 BHP	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	0.206	
AVERAGE HOURLY PROCESS RATE	0.0041	
MAXIMUM HOURLY PROCESS RATE	0.0041	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	50	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	56	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	0.57	mmBTU/hr
MAXIMUM HEAT INPUT	0.57	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	116	0.06	2.31	2.31	1.66E-03	2.92E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	7	0.00	0.14	0.14	9.85E-05	1.73E-02
Carbon Monoxide (CO)	314.64	102.0	21	0.01	0.42	0.42	3.03E-04	5.30E-02
Sulfur Dioxide (SO_2)	0.29	0.213	0	0.00	0.00	0.00	6.32E-07	1.11E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	7	0.00	0.14	0.14	9.94E-05	1.74E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	4,635	2.32	92.70	92.70	6.67E-02	1.17E+01
Ammonia Slip (NH_3)	0	0.000	-	0.00	0.00	0.00	0.00E+00	0.00E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr	tons/yr	lb/hr
Nitrogen Oxides (as NO_2)	18.768	13.996	0.06	2.31
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828	0.00	0.14
Carbon Monoxide (CO)	3.412	2.545	0.01	0.42
Sulfur Dioxide (SO_2)	0.0071	0.0053	0.00	0.00
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836	0.00	0.14
Carbon Dioxide (CO_2)	751.821	560.642	2.32	92.70
Ammonia Slip (NH_3)	-	-	-	0.00

Freefall Lifeboat

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene	1.28E-01	1.28E-01	0.03	0.0000	0.0005	0.0005	3.79E-07	6.64E-05
Formaldehyde	1.62E-01	1.62E-01	0.03	0.0000	0.0007	0.0007	4.80E-07	8.40E-05
PAHs	1.14E-02	1.14E-02	0.00	0.0000	0.0000	0.0000	3.38E-08	5.92E-06
Naphthalene	1.16E-02	1.16E-02	0.00	0.0000	0.0000	0.0000	3.45E-08	6.04E-06
Acetaldehyde	1.05E-01	1.05E-01	0.02	0.0000	0.0004	0.0004	3.12E-07	5.46E-05
Acrolein	1.27E-02	1.27E-02	0.00	0.0000	0.0001	0.0001	3.76E-08	6.59E-06
Propylene	3.53E-01	3.53E-01	0.07	0.0000	0.0015	0.0015	1.05E-06	1.84E-04
Toluene	5.60E-02	5.60E-02	0.01	0.0000	0.0002	0.0002	1.66E-07	2.91E-05
Xylenes	3.90E-02	3.90E-02	0.01	0.0000	0.0002	0.0002	1.16E-07	2.03E-05
Ethyl Benzene	n/a							
Hexane	n/a							
Butadiene -1,3	5.36E-03	5.36E-03	0.00	0.0000	0.0000	0.0000	1.59E-08	2.78E-06
Propylene Oxide	n/a							

Diesel Storage Tank

SIC	1321	
PROCESS EQPT DESCRIPTION	Standby Diesel Fuel Storage Tank	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	107.910	
AVERAGE HOURLY PROCESS RATE	0.012	
MAXIMUM HOURLY PROCESS RATE	0.012	
PROCESS UNITS	PT031	1000 GALLONS THROUGHPUT
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	8760	
TOTAL YEARLY PROCESS RATE	54.3	
AVERAGE HOURLY PROCESS RATE	0.0062	
MAXIMUM HOURLY PROCESS RATE	0.0062	
PROCESS UNITS	PT079	POUNDS (VOC)

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)								
Reactive Hydrocarbons (ROC) as CH_4		1.0	54.3	0.027	0.006	0.006	7.81E-04	7.81E-04
Carbon Monoxide (CO)								
Sulfur Dioxide (SO_2)								
Particulates (as PM_{10}) (grains/dscf)								
Carbon Dioxide (CO_2)								
Ammonia Slip (NH_3)								

Diesel Storage Tank

SCAQMD AP-42 Fixed Roof Eqns.	Value	Units	
Number of Tanks	1		
Tank Diameter, D	30.000	ft	
Shell Height, Hs	17.4747	ft	333.3 m3
Vapor Outage Headspace, Hvo	8.737	ft	2096 bbl
Tank Capacity, C	2200.010	bbl	5% safety margin
Throughput, Q	2569.291	bbl/yr	
Turnovers, N	1.168	#/yr	
True Vapor Pressure, P	0.009	psia	
Vapor Molecular Weight, Mv	130	lb/lb-mole	
Storage Temperature, Ts	65	F	
Delta Temp, Tv	25	F	
Paint Alpha, a	0.1700	a	
Product Factor, Kp	1.0000		
Vapor Space Volume, Vv	6176.0688	ft3	
Vapor Density, Wv	0.0002	lb/ft3	
Vapor Space Expansion Factor, Ke	0.0352		
Vapor Saturation Factor, Kv	0.9958		
Turnover Factor, Kn	1.0000		
Beathing Loss, Lb	16.3940	lb/yr	
Working Loss, Lw	3.0061	lb/yr	
Total Tank Losses, Lt	19.4001	lb/yr	

Backup Gen	Emergency	Lifeboats	Total
878.6	1685.8	4.9	2569.3
bbl/yr	bbl/yr	bbl/yr	bbl/yr

Backup Gen	Emergency	Lifeboats
369.0	354.0	4.1
gal/hr	gal/hr	gal/hr

	Combined		Capacity
	127.8		92,400
	hours		gals

Fugitive Components	lb/yr	EF, lb/hr	Count
Valves, Gas	0.0000	0.012	
Valves, Light Liquid	0.0000	0.016	
Valves, Heavy Liquid	67.0140	0.00051	15
Flanges, General	31.5360	0.0018	2
Pump Seals, Light Liquid	0.0000	0.11	
Pump Seals, Heavy Liquid	823.4400	0.047	2
Pressure Relief Valves	0.0000	0.23	
Low Pressure Correction Factor	0.0379		
Total Fugitive Losses, Lf	34.9082		

Total Emissions, Et	54.3084	lb/yr

Diesel Storage Tank

HAP NAME	UNCTL EF LBS/UNIT	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Benzene			4.78E-02	2.39E-05	5.46E-06	5.46E-06	6.87E-07	6.87E-07
Formaldehyde								
PAHs								
Naphthalene								
Acetaldehyde								
Acrolein								
Propylene								
Toluene			2.62E-01	1.31E-04	2.99E-05	2.99E-05	3.77E-06	3.77E-06
Xylenes			2.28E-01	1.14E-04	2.60E-05	2.60E-05	3.28E-06	3.28E-06
Ethyl Benzene								
Hexane								
Butadiene -1,3								
Propylene Oxide								

Scarborough LNG

Component Gas	Chemical Formula	Molecular Weight	HHV btu/scf	Composition mole fraction	Composition Mole Wt	HHV btu/scf	HHV btu/lb
Carbon Dioxide	CO_2	44.010		0.000056	0.00246		
Nitrogen	N_2	28.013		0.003428	0.09603		
Methane	CH_4	16.043	1014.2	0.995108	15.96452	1009.25	
Ethane	C_2H_6	30.070	1776.7	0.001130	0.03398	2.01	
Propane	C_3H_8	44.097	2528.7	0.000113	0.00498	0.29	
i-Butane	C_4H_{10}	58.124	3267.2	0.000091	0.00529	0.30	
n-Butane	C_4H_{10}	58.124	3276.7	0.000068	0.00395	0.22	
i-Pentane	C_5H_{12}	72.151	4018.2	0.000000	0.00000	0.00	
n-Pentane	C_5H_{12}	72.151	4027.5	0.000006	0.00043	0.02	
TOTAL				**1.00000**	**16.112**	**1012.08**	**24,204.94**

	C	F
LNG Temperature	-160.9	-257.62
Standard Gas Temperature	20.0	68.0

	l/g-mole	ft^3/lb-mole
Standard Molar Volume	24.055	385.324

	kg/m^3	lb/ft^3
LNG Density	424.1	26.476
Standard Gas Density	0.6698	0.0418

SCV Heat Input	Value	Units		
Gas Flowrate	744.75	kg/hr	each	
Gas Flowrate	1642	lb/hr	each	
Heat Input	39.74	mmBTU/hr	each	mass basis
Gas Flowrate	39.27	mcf/hr	each	
Heat Input	39.74	mmBTU/hr	each	volume basis

Vessels Combined Summary

EMITTENT NAME	Tons Per Year (CA diesel fuel, LNG Carrier on Gas)				
	Assist Tugs	Crew Boat	Supply Boat	Total	LNG Carrier
Nitrogen Oxides (as NO_2)	98.6	1.6	13.0	**113.3**	106.2
Reactive Organic Compounds (ROC) as CH_4	5.8	0.1	0.8	**6.7**	14.8
Carbon Monoxide (CO)	17.9	0.3	2.4	**20.6**	69.8
Sulfur Dioxide (SO_2)	0.04	0.001	0.005	**0.0**	0.0
Particulates (as PM_{10})	5.9	0.1	0.8	**6.8**	1.3
Carbon Dioxide (CO_2)	3,951	66	521	**4,538**	13,786

EMITTENT NAME	Emission Rates (CA diesel fuel, LNG Carrier on Gas)				
	Assist Tugs	Crew Boat	Supply Boat	Average	LNG Carrier
	g/BHP-hr	g/BHP-hr	g/BHP-hr	g/BHP-hr	g/BHP-hr
Nitrogen Oxides (as NO_2)	14.00	14.00	14.00	14.00	2.44
Reactive Organic Compounds (ROC) as CH_4	0.83	0.83	0.83	0.83	0.34
Carbon Monoxide (CO)	2.54	2.54	2.54	2.54	1.61
Sulfur Dioxide (SO_2)	0.01	0.01	0.01	0.01	0.00
Particulates (as PM_{10})	0.84	0.84	0.84	0.84	0.03
Carbon Dioxide (CO_2)	560.64	560.64	560.64	560.64	317.47

Vessel Notes:
Assist tugs (pair) conducting LNG carrier to FSRU berthing operations 120 times per year, time & load weighted engine operation
Crew boat making weekly round trip to FSRU, time & load weighted engine operation
Supply boat making semi-weekly round trip to FSRU, time & load weighted engine operation
LNG carrier to FSRU berthing operations, 14 miles slow, 3 miles to FSRU with assist tugs, time & load weighted engine operation

Vessels Uncontrolled Summary

EMITTENT NAME	Tons Per Year (CA diesel fuel)					
	Assist Tugs	Crew Boat	Supply Boat	Total		LNG Carrier
Nitrogen Oxides (as NO_2)	98.6	1.6	13.0	**113.3**		550.5
Reactive Organic Compounds (ROC) as CH_4	5.8	0.1	0.8	**6.7**		43.9
Carbon Monoxide (CO)	17.9	0.3	2.4	**20.6**		161.9
Sulfur Dioxide (SO_2)	0.04	0.001	0.005	**0.0**		0.2
Particulates (as PM_{10})	5.9	0.1	0.8	**6.8**		16.2
Carbon Dioxide (CO_2)	3,951	66	521	**4,538**		20,553

EMITTENT NAME	Emission Rates (CA diesel fuel)					
	Assist Tugs	Crew Boat	Supply Boat	Average		LNG Carrier
	g/BHP-hr	g/BHP-hr	g/BHP-hr	g/BHP-hr		g/BHP-hr
Nitrogen Oxides (as NO_2)	14.00	14.00	14.00	14.00		12.68
Reactive Organic Compounds (ROC) as CH_4	0.83	0.83	0.83	0.83		1.01
Carbon Monoxide (CO)	2.54	2.54	2.54	2.54		3.73
Sulfur Dioxide (SO_2)	0.01	0.01	0.01	0.01		0.00
Particulates (as PM_{10})	0.84	0.84	0.84	0.84		0.37
Carbon Dioxide (CO_2)	560.64	560.64	560.64	560.64		473.32

Vessel Notes:
Assist tugs (pair) conducting LNG carrier to FSRU berthing operations 120 times per year, time & load weighted engine operation
Crew boat making weekly round trip to FSRU, time & load weighted engine operation
Supply boat making semi-weekly round trip to FSRU, time & load weighted engine operation
LNG carrier to FSRU berthing operations, 14 miles slow, 3 miles to FSRU with assist tugs, time & load weighted engine operation

Vessels wit.)as Carriers

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year					
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2
2	Assist Tugs	9,250 BHP Total	CA Diesel	98.6	5.8	17.9	0.04	5.9	3,951
1	Crew Boat	875 BHP Total	CA Diesel	1.6	0.1	0.3	0.00	0.1	66
1	Supply Boat	3,250 BHP Total	CA Diesel	13.0	0.8	2.4	0.00	0.8	521
1	LNG Carrier	45,600 BHP Total	Natural Gas	106.2	14.8	69.8	0.0	1.3	13,786
Total Emissions (LNG Carrier on gas)				**219.4**	**21.5**	**90.4**	**0.1**	**8.0**	**18,324**

Vessel Notes:
Assist tugs (pair) conducting LNG carrier to FSRU berthing operations 120 times per year, time & load weighted engine operation
Crew boat making weekly round trip to FSRU, time & load weighted engine operation
Supply boat making semi-weekly round trip to FSRU, time & load weighted engine operation
LNG carrier to FSRU berthing operations, 14 miles slow, 3 miles to FSRU with assist tugs, time & load weighted engine operation

Vessels w[illegible] all Diesel

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year					
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2
2	Assist Tugs	9,250 BHP Total	CA Diesel	98.6	5.8	17.9	0.04	5.9	3,951
1	Crew Boat	875 BHP Total	CA Diesel	1.6	0.1	0.3	0.00	0.1	66
1	Supply Boat	3,250 BHP Total	CA Diesel	13.0	0.8	2.4	0.00	0.8	521
1	LNG Carrier	45,600 BHP Total	CA Diesel	550.5	43.9	161.9	0.19	16.2	20,553
Total Emissions (all CA diesel vessels)				**663.8**	**50.6**	**182.5**	**0.24**	**23.0**	**25,091**

Vessel Notes:

Assist tugs (pair) conducting LNG carrier to FSRU berthing operations 120 times per year, time & load weighted engine operation

Crew boat making weekly round trip to FSRU, time & load weighted engine operation

Supply boat making semi-weekly round trip to FSRU, time & load weighted engine operation

LNG carrier to FSRU berthing operations, 14 miles slow, 3 miles to FSRU with assist tugs, time & load weighted engine operation

(2) Assist Tugs Mains

SIC	1321	
PROCESS EQPT DESCRIPTION	Assist Tug Main Engines	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	304.13	
AVERAGE HOURLY PROCESS RATE	0.1056	
MAXIMUM HOURLY PROCESS RATE	0.1056	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	2	
COMBINED ENGINE RATING	8000	BHP
LOAD FACTOR	12%	percent
HRS/YEAR	2880	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	1432	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	14.47	mmBTU/hr
MAXIMUM HEAT INPUT	14.47	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	170,616	85.31	59.24	59.24	2.45E+00	7.46E+00
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	10,097	5.05	3.51	3.51	1.45E-01	4.42E-01
Carbon Monoxide (CO)	314.64	102.0	31,021	15.51	10.77	10.77	4.46E-01	1.36E+00
Sulfur Dioxide (SO_2)	0.29	0.213	65	0.03	0.02	0.02	9.32E-04	2.83E-03
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	10,188	5.09	3.54	3.54	1.47E-01	4.46E-01
Carbon Dioxide (CO_2)	4.41%	22472.9	6,834,644	3417.32	2373.14	2373.14	9.83E+01	2.99E+02

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

(2) Assist Tugs Bow

SIC	1321	
PROCESS EQPT DESCRIPTION	Assist Tug Bow Thruster Engine	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	7.92	
AVERAGE HOURLY PROCESS RATE	0.0550	
MAXIMUM HOURLY PROCESS RATE	0.0550	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	2	
COMBINED ENGINE RATING	1000	BHP
LOAD FACTOR	50%	percent
HRS/YEAR	144	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	746	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	7.54	mmBTU/hr
MAXIMUM HEAT INPUT	7.54	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	4,443	2.22	30.86	30.86	6.39E-02	3.89E+00
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	263	0.13	1.83	1.83	3.78E-03	2.30E-01
Carbon Monoxide (CO)	314.64	102.0	808	0.40	5.61	5.61	1.16E-02	7.07E-01
Sulfur Dioxide (SO_2)	0.29	0.213	2	0.00	0.01	0.01	2.43E-05	1.48E-03
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	265	0.13	1.84	1.84	3.82E-03	2.32E-01
Carbon Dioxide (CO_2)	4.41%	22472.9	177,986	88.99	1236.01	1236.01	2.56E+00	1.56E+02

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

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(2) Assist Tugs Gen

SIC	1321	
PROCESS EQPT DESCRIPTION	Assist Tug Generator Engine (redundant pair)	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	39.60	
AVERAGE HOURLY PROCESS RATE	0.0138	
MAXIMUM HOURLY PROCESS RATE	0.0138	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	2	
COMBINED ENGINE RATING	250	BHP
LOAD FACTOR	50%	percent
HRS/YEAR	2880	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	186	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	1.88	mmBTU/hr
MAXIMUM HEAT INPUT	1.88	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	22,216	11.11	7.71	7.71	3.20E-01	9.72E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	1,315	0.66	0.46	0.46	1.89E-02	5.75E-02
Carbon Monoxide (CO)	314.64	102.0	4,039	2.02	1.40	1.40	5.81E-02	1.77E-01
Sulfur Dioxide (SO_2)	0.29	0.213	8	0.00	0.00	0.00	1.21E-04	3.69E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	1,327	0.66	0.46	0.46	1.91E-02	5.80E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	889,928	444.96	309.00	309.00	1.28E+01	3.89E+01

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

Assist Tugs

Berthing Activity	Miles	Speed	Time, hrs	Mains	Weighted
Cruise to LNG Carrier	23	16.0	1.4	60%	3.6%
Assist Carrier to FSRU	3	5.0	0.6	100%	2.5%
Unload Standby	0	stop	20.0	0%	0.0%
Assist Carrier to Release	3	5.0	0.6	100%	2.5%
Cruise to Dock	23	16.0	1.4	60%	3.6%
Composite			24.1		12.1%

Remarks

1 carrier every three days = 120 berthings/year
120 bethings/yr x 24 hrs = 2880 hrs/yr @ 12% power on mains
bow thrusters used only during berthing
120 bethings/yr x 1.2 hrs = 144 hrs/yr @ 50% power on thruster
ship generators run all the time, so
120 bethings/yr x 24 hrs = 2880 hrs/yr @ 50% power

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Crew Boat Mains

SIC	1321	
PROCESS EQPT DESCRIPTION	Crew Boat Main Engines	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	5.13	
AVERAGE HOURLY PROCESS RATE	0.0141	
MAXIMUM HOURLY PROCESS RATE	0.0141	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	800	BHP
LOAD FACTOR	32%	percent
HRS/YEAR	364	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	191	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	1.93	mmBTU/hr
MAXIMUM HEAT INPUT	1.93	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	2,875	1.44	7.90	7.90	4.14E-02	9.95E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	170	0.09	0.47	0.47	2.45E-03	5.89E-02
Carbon Monoxide (CO)	314.64	102.0	523	0.26	1.44	1.44	7.52E-03	1.81E-01
Sulfur Dioxide (SO_2)	0.29	0.213	1	0.00	0.00	0.00	1.57E-05	3.78E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	172	0.09	0.47	0.47	2.47E-03	5.94E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	115,176	57.59	316.42	316.42	1.66E+00	3.99E+01

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

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Crew Boat Gen

SIC	1321	
PROCESS EQPT DESCRIPTION	Crew Boat Generator Engine (redundant pair)	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	0.75	
AVERAGE HOURLY PROCESS RATE	0.0021	
MAXIMUM HOURLY PROCESS RATE	0.0021	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	75	BHP
LOAD FACTOR	50%	percent
HRS/YEAR	364	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	28	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	0.28	mmBTU/hr
MAXIMUM HEAT INPUT	0.28	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	421	0.21	1.16	1.16	6.06E-03	1.46E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	25	0.01	0.07	0.07	3.59E-04	8.63E-03
Carbon Monoxide (CO)	314.64	102.0	77	0.04	0.21	0.21	1.10E-03	2.65E-02
Sulfur Dioxide (SO_2)	0.29	0.213	0	0.00	0.00	0.00	2.30E-06	5.54E-05
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	25	0.01	0.07	0.07	3.62E-04	8.71E-03
Carbon Dioxide (CO_2)	4.41%	22472.9	16,872	8.44	46.35	46.35	2.43E-01	5.84E+00

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

Crew Boat Activity

Crew Boats **Cruise =** **18 kts**

Support Activity	Miles	Speed	Time, hrs	Mains	Weighted
Cruise to FSRU	20	18.0	1.1	100%	16.1%
Loiter FSRU	1.5	2.0	0.8	1%	0.1%
Unload Standby	0	stop	3.2	0%	0.0%
Loiter FSRU	1.5	2.0	0.8	1%	0.1%
Cruise to FSRU	20	18.0	1.1	100%	16.1%
Composite			6.9		32.4%

Remarks

1 trip per week
52 trips/yr x 7 hrs = 364 hrs/yr @ 32% power on mains
ship generators run all the time, so
52 trips/yr x 7 hrs = 364 hrs/yr @ 50% power

Supply Boat Mains

SIC	1321	
PROCESS EQPT DESCRIPTION	Supply Boat Main Engines	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	36.18	
AVERAGE HOURLY PROCESS RATE	0.0316	
MAXIMUM HOURLY PROCESS RATE	0.0316	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	2500	BHP
LOAD FACTOR	23%	percent
HRS/YEAR	1144	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	429	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	4.33	mmBTU/hr
MAXIMUM HEAT INPUT	4.33	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	20,296	10.15	17.74	17.74	2.92E-01	2.24E+00
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	1,201	0.60	1.05	1.05	1.73E-02	1.32E-01
Carbon Monoxide (CO)	314.64	102.0	3,690	1.85	3.23	3.23	5.31E-02	4.06E-01
Sulfur Dioxide (SO_2)	0.29	0.213	8	0.00	0.01	0.01	1.11E-04	8.49E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	1,212	0.61	1.06	1.06	1.74E-02	1.33E-01
Carbon Dioxide (CO_2)	4.41%	22472.9	813,048	406.52	710.71	710.71	1.17E+01	8.95E+01

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

Supply Boat Bow

SIC	1321	
PROCESS EQPT DESCRIPTION	Supply Boat Bow Thruster Engine	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	2.29	
AVERAGE HOURLY PROCESS RATE	0.0138	
MAXIMUM HOURLY PROCESS RATE	0.0138	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	500	BHP
LOAD FACTOR	50%	percent
HRS/YEAR	166	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	186	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	1.88	mmBTU/hr
MAXIMUM HEAT INPUT	1.88	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	1,284	0.64	7.71	7.71	1.85E-02	9.72E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	76	0.04	0.46	0.46	1.09E-03	5.75E-02
Carbon Monoxide (CO)	314.64	102.0	233	0.12	1.40	1.40	3.36E-03	1.77E-01
Sulfur Dioxide (SO_2)	0.29	0.213	0	0.00	0.00	0.00	7.01E-06	3.69E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	77	0.04	0.46	0.46	1.10E-03	5.80E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	51,418	25.71	309.00	309.00	7.40E-01	3.89E+01

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

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Supply Boat Gen

SIC	1321	
PROCESS EQPT DESCRIPTION	Supply Boat Generator Engine (redundant pair)	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	7.87	
AVERAGE HOURLY PROCESS RATE	0.0069	
MAXIMUM HOURLY PROCESS RATE	0.0069	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	250	BHP
LOAD FACTOR	50%	percent
HRS/YEAR	1144	
HEAT RATE	10107	BTU/kw-hr
UNIT RATING	93	KW
CONVERSION EFFICIENCY	33.8%	
AVERAGE HEAT INPUT	0.94	mmBTU/hr
MAXIMUM HEAT INPUT	0.94	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1053.36	561.0	4,412	2.21	3.86	3.86	6.35E-02	4.86E-01
Reactive Hydrocarbons (ROC) as CH_4	179.22	33.2	261	0.13	0.23	0.23	3.76E-03	2.88E-02
Carbon Monoxide (CO)	314.64	102.0	802	0.40	0.70	0.70	1.15E-02	8.84E-02
Sulfur Dioxide (SO_2)	0.29	0.213	2	0.00	0.00	0.00	2.41E-05	1.85E-04
Particulates (as PM_{10}) (grains/dscf)	0.0526	33.5	263	0.13	0.23	0.23	3.79E-03	2.90E-02
Carbon Dioxide (CO_2)	4.41%	22472.9	176,750	88.37	154.50	154.50	2.54E+00	1.95E+01

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	18.768	13.996
Reactive Hydrocarbons (ROC) as CH_4	1.111	0.828
Carbon Monoxide (CO)	3.412	2.545
Sulfur Dioxide (SO_2)	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	1.121	0.836
Carbon Dioxide (CO_2)	751.821	560.642

Supply Boats **Cruise =** **16 kts**

Support Activity	Miles	Speed	Time, hrs	Mains	Weighted
Cruise to FSRU	20	16.0	1.3	100%	11.4%
Loiter FSRU	1.5	2.0	0.8	2%	0.1%
Unload Standby	0	stop	7.0	0%	0.0%
Loiter FSRU	1.5	2.0	0.8	2%	0.1%
Cruise to FSRU	20	16.0	1.3	100%	11.4%
Composite			11.0		22.9%

Remarks

2 trips per week
104 trips/yr x 11 hrs = 1144 hrs/yr @ 23% power on mains
bow thrusters used only during berthing
104 bethings/yr x 1.6 hrs = 166 hrs/yr @ 50% power on thruster
ship generators run all the time, so
104 trips/yr x 11 hrs = 1144 hrs/yr @ 50% power

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LNG Carrier (California diesel)

SIC	1321	
PROCESS EQPT DESCRIPTION	LNG Carrier Ship All Engines, 34,000 KW Total	
FUEL TYPE/PROCESS INFO	Rule 431.2 Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	1829.17	
AVERAGE HOURLY PROCESS RATE	0.6351	
MAXIMUM HOURLY PROCESS RATE	0.6351	
PROCESS UNITS	PT024	1000 Gallons Burned
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	45594	BHP
LOAD FACTOR	30%	percent
HRS/YEAR	2880	
HEAT RATE	8533	BTU/kw-hr
UNIT RATING	10200	KW
CONVERSION EFFICIENCY	40.0%	
AVERAGE HEAT INPUT	87.03	mmBTU/hr
MAXIMUM HEAT INPUT	87.03	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	1130.16	601.901	1,100,977	550.49	382.28	382.28	1.58E+01	4.82E+01
Reactive Hydrocarbons (ROC) as CH_4	258.90	48.0	87,728	43.86	30.46	30.46	1.26E+00	3.84E+00
Carbon Monoxide (CO)	546.09	177.030	323,817	161.91	112.44	112.44	4.66E+00	1.42E+01
Sulfur Dioxide (SO_2)	0.29	0.213	390	0.19	0.14	0.14	5.60E-03	1.70E-02
Particulates (as PM_{10}) (grains/dscf)	0.0278	17.703	32,382	16.19	11.24	11.24	4.66E-01	1.42E+00
Carbon Dioxide (CO_2)	4.41%	22472.9	41,106,718	20553.36	14273.17	14273.17	5.91E+02	1.80E+03

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	17.000	12.677
Reactive Hydrocarbons (ROC) as CH_4	1.355	1.010
Carbon Monoxide (CO)	5.000	3.729
Sulfur Dioxide (SO_2)	0.006	0.004
Particulates (as PM_{10}) (grains/dscf)	0.500	0.373
Carbon Dioxide (CO_2)	634.722	473.320

LNG Carrier (gas)

SIC	1321	
PROCESS EQPT DESCRIPTION	LNG Carrier Ship All Engines, 34,000 KW Total	
FUEL TYPE/PROCESS INFO	Raw LNG, 95.5% methane, 1 ppm S	
TOTAL YEARLY PROCESS RATE	247.658	
AVERAGE HOURLY PROCESS RATE	0.0860	
MAXIMUM HOURLY PROCESS RATE	0.0860	
PROCESS UNITS	PT074	Million Cubic Feet Burned
HIGHER HEATING VALUE	1012.1	mmBTU/mmcf
NUMBER OF DEVICES	1	
COMBINED ENGINE RATING	45594	BHP
LOAD FACTOR	30%	percent
HRS/YEAR	2880	
HEAT RATE	8533	BTU/kw-hr
UNIT RATING	10200	KW
CONVERSION EFFICIENCY	40.0%	
AVERAGE HEAT INPUT	87.03	mmBTU/hr
MAXIMUM HEAT INPUT	87.03	mmBTU/hr

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)	229.94	857.234	212,301	106.15	73.72	73.72	3.05E+00	9.29E+00
Reactive Hydrocarbons (ROC) as CH_4	92.10	119.426	29,577	14.79	10.27	10.27	4.25E-01	1.29E+00
Carbon Monoxide (CO)	248.42	563.730	139,612	69.81	48.48	48.48	2.01E+00	6.11E+00
Sulfur Dioxide (SO_2)	0.03	0.166	41	0.02	0.01	0.01	5.92E-04	1.80E-03
Particulates (as PM_{10}) (grains/dscf)	0.0023	10.108	2,503	1.25	0.87	0.87	3.60E-02	1.10E-01
Carbon Dioxide (CO_2)	3.12%	111329.127	27,571,579	13785.79	9573.47	9573.47	3.97E+02	1.21E+03

EMITTENT NAME	g/kw-hr	g/bhp-hr
Nitrogen Oxides (as NO_2)	3.278	2.445
Reactive Hydrocarbons (ROC) as CH_4	0.457	0.341
Carbon Monoxide (CO)	2.156	1.608
Sulfur Dioxide (SO_2)	0.0006	0.0005
Particulates (as PM_{10}) (grains/dscf)	0.039	0.029
Carbon Dioxide (CO_2)	425.728	317.471

LNG Carrier Activity

LNG Carriers **Cruise =** **19.5 kts**

Berthing Activity	Miles	Speed	Time, hrs	KW	Weighted
25 to 11 miles	14	12.0	1.2	15000	728
11 to 8 miles	3	Towed	0.6	5000	125
Unload	0	stop	20.5	10000	8530
8 to 11 miles	3	Towed	0.6	5000	125
11 to 25 miles	14	12.0	1.2	15000	728
Composite			24.0		10236
Rating					34000
Load Factor					30%

Remarks

1 carrier every three days = 120 berthings/year

120 bethings/yr x 24 hrs = 2880 hrs/yr @ 30% power

Construction Emissions of Criteria Pollutants

Phase	NO_x lbs/day	SO_x lbs/day	CO lbs/day	PM_{10} lbs/day	VOC lbs/day
MOORING	4,315.4	1.6	784.6	257.7	255.0
PIPE-LAY	11,991.8	12.7	2,200.4	718.5	715.2
TOTAL	16,307.2	14.3	2,985.0	976.2	970.2

Assumptions
Mooring Installation (Vessels @ 35% loading):
1x AHTS @ 12,000 Hp
1x AHTS @ 15,000 Hp
2x supply vessels @ 4500 Hp each
2x barges to transport anchors and equipment (not powered)
Assume 12 hours per day running
Pipeline Installation (Vessels @ 35% loading):
1x Dynamically positioned pipelay vessel @ 37,800 Hp (24 hours per day)
10x diesel welding units (0.8 hours per day)
4x supply vessels @ 4500 Hp each (average 12 hours per day or 2x vessels at 24 hours per day)
2x cranes (shore side) abt 100 ton capacity (pipe handling / loading) (avg 6 hours per day run time)
2x cranes (shore side) abt 35 ton capacity (pipe handling / loading) (avg 6 hours per day run time)
4x pipe barges to transport pipe and material offshore (not powered)
two (2) 18 wheelers traveling total of 2700 mi/construction period

Vessel Emission Factors Units: lbs/1000 gallons fuel

NO_x	561
SO_x	0.213
CO	102
PM_{10}	33.5
VOC	33.15

Source: US EPA 2000. AP-42 Emission Factors for Mobile Sources.
Truck Emission Factors from Calif. Air Resources Board' (2000) EMFAC2000 (summer, 70 F, 50% relative humidity) non-enhanced I/M, 35 mph
Diesel cranes and welding units emission factors taken from SCAQMD 1993. CEQA Air Quality Handbook, Table 9-8-C.

Mooring Operations

EQUIPMENT NAME	Number Vessels	Number Devices	engine rating (total) bhp	FUEL CONS g/bhp-hr	HRS/DAY	gpd	total gallons consumed	load	#hrs total	#days total						NOX lbs/phase	SOX lbs/phase	CO lbs/phase	PM10 lbs/phase	voc lbs/phase
AHTS MAINS	1	2	10750	0.055	12	7095	319275	0.35	540	45.0						62689.6	23.8	11398.1	3743.5	3704.4
AHTS BOW*	1	2	1000	0.055	1.2	66	2970	0.35	54	45.0						583.2	0.2	106.0	34.8	34.5
AHTS GENS	1	2	250	0.055	12	165	7425	0.35	540	45.0						1457.9	0.6	265.1	87.1	86.1
AHTS MAINS	1	2	13750	0.055	12	9075	408375	0.35	540	45.0						80184.4	30.4	14579.0	4788.2	4738.2
AHTS BOW*	1	2	1000	0.055	1.2	66	2970	0.35	54	45.0						583.2	0.2	106.0	34.8	34.5
AHTS GENS	1	2	250	0.055	12	165	7425	0.35	540	45.0						1457.9	0.6	265.1	87.1	86.1
SUPPLY BOAT MAINS	2	2	7500	0.055	12	4950	222750	0.35	540	45.0						43737.0	16.6	7952.2	2611.7	2584.5
SUPPLY BOAT BOW*	2	2	1000	0.055	1.2	66	2970	0.35	54	45.0						583.2	0.2	106.0	34.8	34.5
SUPPLY BOAT GENS	2	2	500	0.055	12	330	14850	0.35	540	45.0						2915.8	1.1	530.1	174.1	172.3
										Total	4315.4	1.6	784.6	257.7	255.0	194192.1	73.7	35307.7	11596.1	11475.0
*BOW ENGINES RUN 10% OF TIME										ctl EF lb/1000 gal	561	0.2	102	33.5	33.15					

Pipelay Operations

EQUIPMENT NAME	NUMBER VESSELS	Number Devices	engine rating (total) bhp	FUEL CONS g/bhp-hr	HRS/DAY	gpd or bhp-hr/d	total gallons consumed	load	#hrs total	#days total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NOX lbs/phase	SOX lbs/phase	CO lbs/phase	PM10 lbs/phase	voc lbs/phase
SUPPLY BOAT MAINS	4	4	15000	0.055	12	9900	445500	0.35	540	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87473.9	33.2	15904.4	5223.5	5168.9
SUPPLY BOAT BOW*	4	4	2000	0.055	1	132	5940	0.35	54	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1166.3	0.4	212.1	69.6	68.9
SUPPLY BOAT GENS	4	4	1000	0.055	12	660	29700	0.35	540	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5831.6	2.2	1060.3	348.2	344.6
CRANES 100 TON***	na	2	400	0.055	6	2400	5940	1.00	270	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2484.0	216.0	972.0	216.0	324.0
DIESEL WELDING UNITS***	na	10	500	0.055	0.8	140	990	0.35	36	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	113.4	12.6	69.3	6.3	12.6
PIPELAY VESSEL MAINS	1	2	37800	0.055	24	49896	2245320	0.35	1080	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	440868.6	167.4	80157.9	26326.4	26051.3
CRANES 35 TON***	na	2	260	0.055	6	1560	3861	1.00	270	45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1614.6	140.4	631.8	140.4	210.6
			miles/day	total miles							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	lbs/phase	lbs/phase	lbs/phase	lbs/phase	lbs/phase
18 WHEELER TRUCKS**	na	1	60	2700.0				1.00		45.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.7	0.0	8.3	1.7	2.9
TOTAL											[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	539630.1	572.3	99016.0	32332.1	32183.8

*BOW ENGINES RUN 10% OF TIME

**Source: CARB's EMFAC 2001 (summer, 70 F, 50% relative humidity) non-enhanced I/M, 35 mph

***Emission factors taken from SCAQMD CEQA Air Quality Handbook, Table 9-8-C.

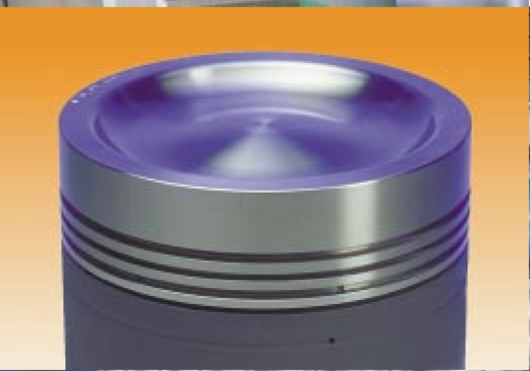
vessels	ctl EF lb/1000gal	561	0.2	102	33.5	33.15
cranes	ctl EF lb/hp-hr	0.023	0.002	0.009	0.002	0.003
welding	ctl EF lb/hp-hr	0.018	0.002	0.011	0.001	0.002
TRUCKS	CTL EF g/mile	13.050		1.390	0.280	0.48

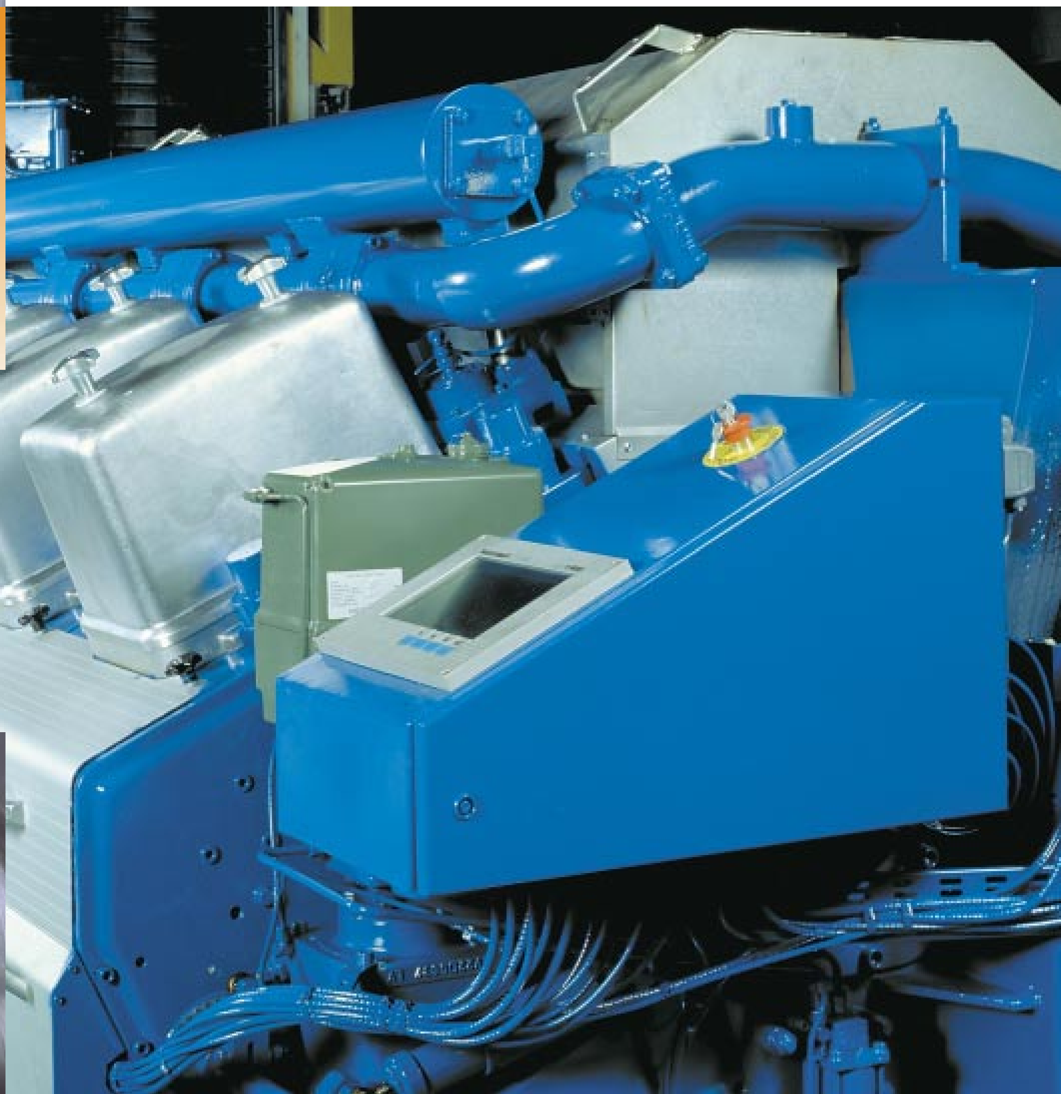
APPENDIX B

VENDOR SPECIFICATIONS

WÄRTSILÄ **32DF**

Technology Review



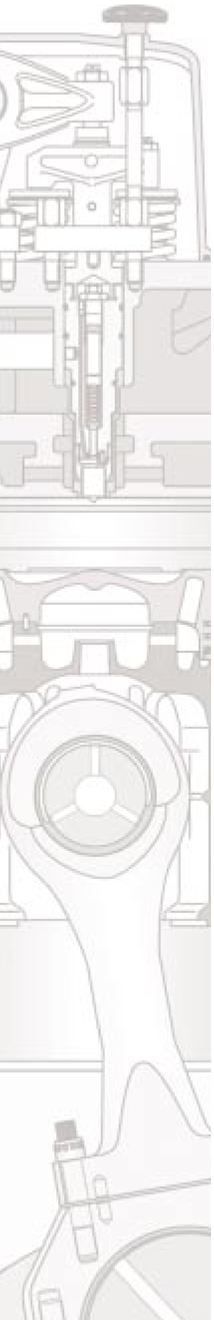


WÄRTSILÄ

WÄRTSILÄ 32DF

Technology Review

This is a brief Guide to the technical features and performance of the Wärtsilä 32DF engine.



Introduction

The Wärtsilä 32DF was developed to set new standards in the market for high-performance, fuel-flexible engines.

The Wärtsilä 32DF is a four-stroke, dual-fuel engine, which means that the engine can be run on either natural gas or light fuel oil. Transfer from one fuel to the other can be done under all operating conditions.

The Wärtsilä 32DF covers a power range of 1400 – 6500 kW. The engine runs at 720 or 750 rpm for use with 50 or 60 Hz generators and produces 335 – 350 kW per cylinder. The Wärtsilä 32DF gives the highest thermal efficiency of any of today ´s gas engines, 43,3 %.

Benefitting from the unique feature of the lean-burn principle in gas mode, NO_x emissions from the Wärtsilä 32DF are extremely low, complying with the most stringent of existing environmental regulations. Today, the natural gas fuelled, lean-burn, medium-speed engine has proved to be a reliable, clean, high efficiency power source. Wärtsilä dual-fuel engines have accumulated a considerable number of operating hours in land-based installations and are mature for marine installations. The Wärtsilä dual-fuel concept for offshore floating production units utilizes the efficient gas engine technology in combination with state of the art controls and auxiliaries forming a total power generation solution that substantially exceeds plant efficiency compared to a typical gas turbine solutions.

Design philosophy

The Wärtsilä 32DF, an engine meeting present and future requirements for life cycle cost of ownership.

Is based on the well-tried Wärtsilä 32 HFO engine and the Wärtsilä 34SG spark-ignited gas engine.

The Wärtsilä 32DF is a technically advanced engine for fuel economy and low emission rates.

Gas admission and pilot fuel injection are both electrically controlled. This means that every cylinder can be individually adjusted under operating for the correct air-fuel ratio and to ensure that minimum amount of pilot fuel is injected for safe and stable combustion. The Wärtsilä 32DF is designed to meet customer demand for a safe and fuel-flexible engine, running on gas as well as on liquid fuel.

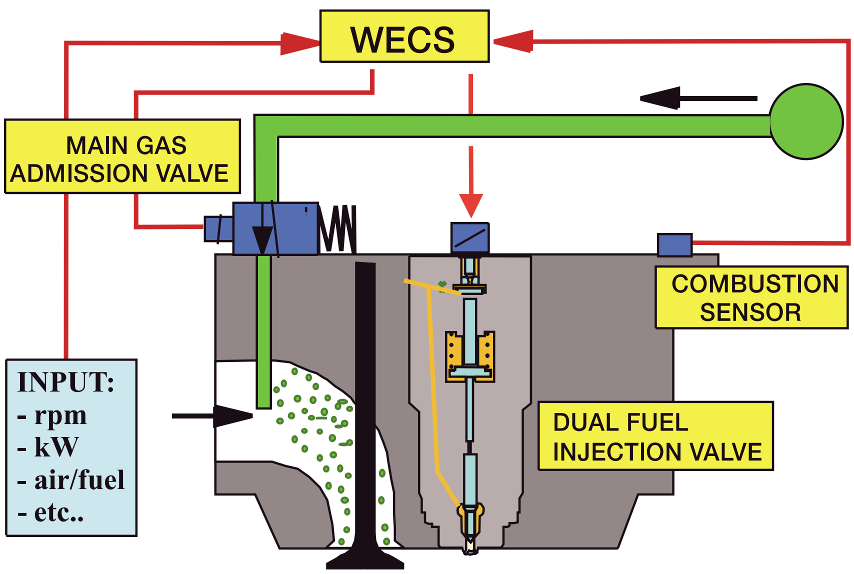
In line with the design philosophy of all Wärtsilä engines, the 32DF has a simple and straightforward design with a minimum of piping and external connections, ample safety margins, facilities for easy and rapid maintenance and a built-in electronically controlled components will ensure that all cylinders stays within the operating window, avoiding knocking and misfiring. This will eliminate unnecessary load reductions and shut-downs.

The Wärtsilä 32DF is designed to give the same output when running on natural gas as on light fuel oil (LFO). The engine is optimised for operation between 500 mg/Nm^3 NO_X at 5 % O_2 in gas mode.

The lean-burn concept

In a lean-burn gas engine the mixture of air and gas in the cylinder is lean, i.e. more air is present in the cylinder than is needed for complete combustion. With leaner combustion, the peak temperature is reduced and less NO_x is produced. Higher output can be reached still avoiding knocking and the efficiency is increased, although too lean mixture will cause misfiring.

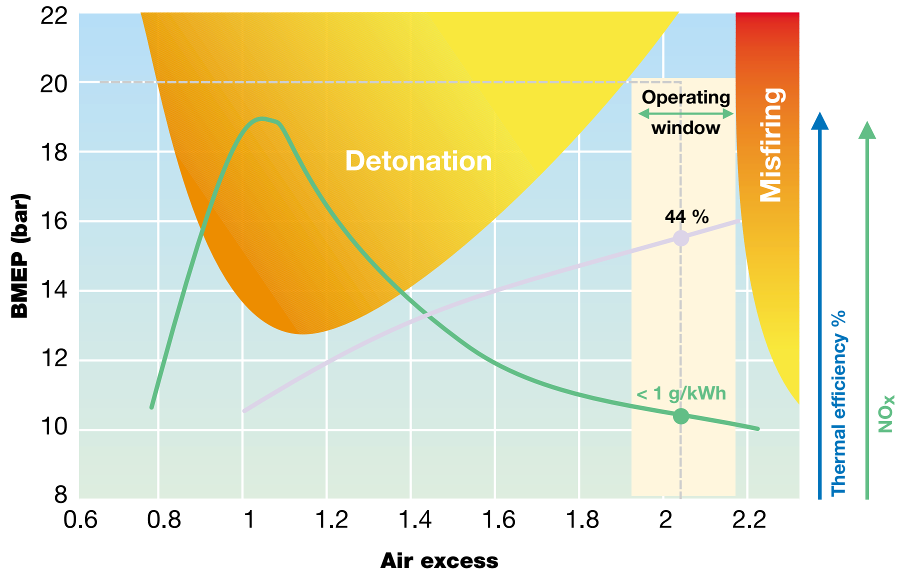
Ignition of the lean air-fuel mixture is initiated with injection of a small amount of LFO (pilot fuel), resulting in a high-energy ignition source. To obtain the best efficiency and the lowest emission, every cylinder is individually controlled to ensure operation at the correct air-fuel ratio and with the correct amount and timing of pilot fuel injection. Stable and well-controlled combustion also contributes to less mechanical and thermal load on engine components. The specially developed control system is designed to meet the challenge in controlling the combustion process in each cylinder, and to remain within the operating window by ensuring optimal performance for all cylinders in terms of efficiency and emission under all conditions.

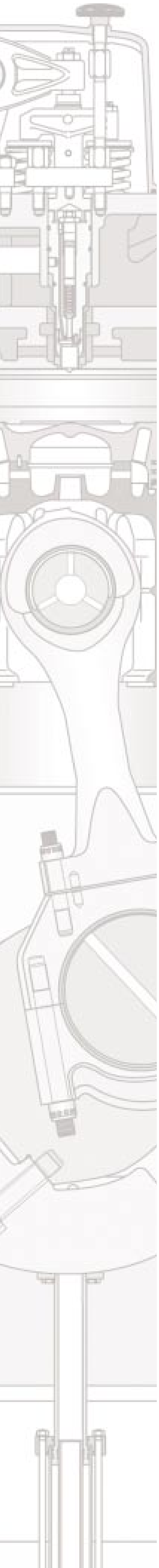


Low emissions

The main parameters governing the rate of NO_x formation in internal combustion engines are peak temperature and residence time. The temperature is reduced by the combustion chamber air-fuel rations: the higher the air-fuel ration the lower the temperature and consequently the lower the NO_x emissions.

In the Wärtsilä 32DF engine, the air-fuel ratio is very high (typically 2.2) and is uniform throughout the cylinders. Maximum temperatures and subsequent NO_x formation are therefore low, since the same specific heat quantity released by combustion is used to heat up a large mass of air. Benefitting from this unique feature of the lean-burn principle, the NO_x emissions from the Wärtsilä 32DF are extremely low, complying with the most stringent of existing legislation.





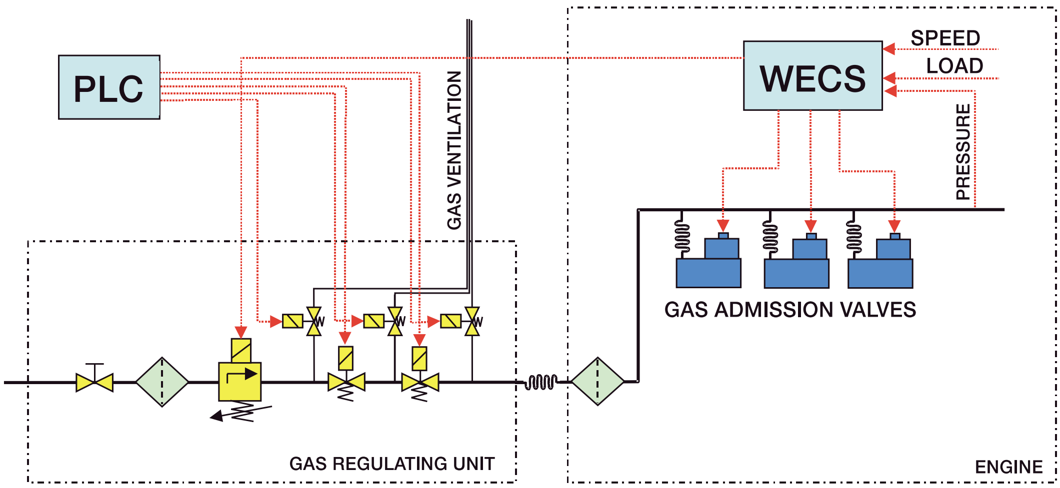
Fuel system

The Wärtsilä 32DF has two fuel supply system, one for gas and the other for diesel oil. The Wärtsilä 32DF can be started in both gas and diesel mode. In gas mode the engine is started only with pilot fuel injection. When combustion is stabilized in every cylinder, gas admission is activated. This procedure ensures safe and reliable starting. When running the engine in gas mode, the pilot fuel amount is less than 1 % of full-load fuel consumption. The pilot fuel amount is controlled by the Wärtsilä Engine Control System (WECS).

Gas Supply System

Before the natural gas is supplied to the engine it passed thought a gasregulating unit, including filter, pressure regulator, shutoff valves and ventilating valves. The external pressure regulator regulates the gas pressure to the correct value under different loads; however, the maximum pressure needed is not more than 3.5 bar under full load. In the engine the gas is supplied through common pipes running along the engine, continuing with individual feed pipes to each gas admission valve located on each cylinder head.

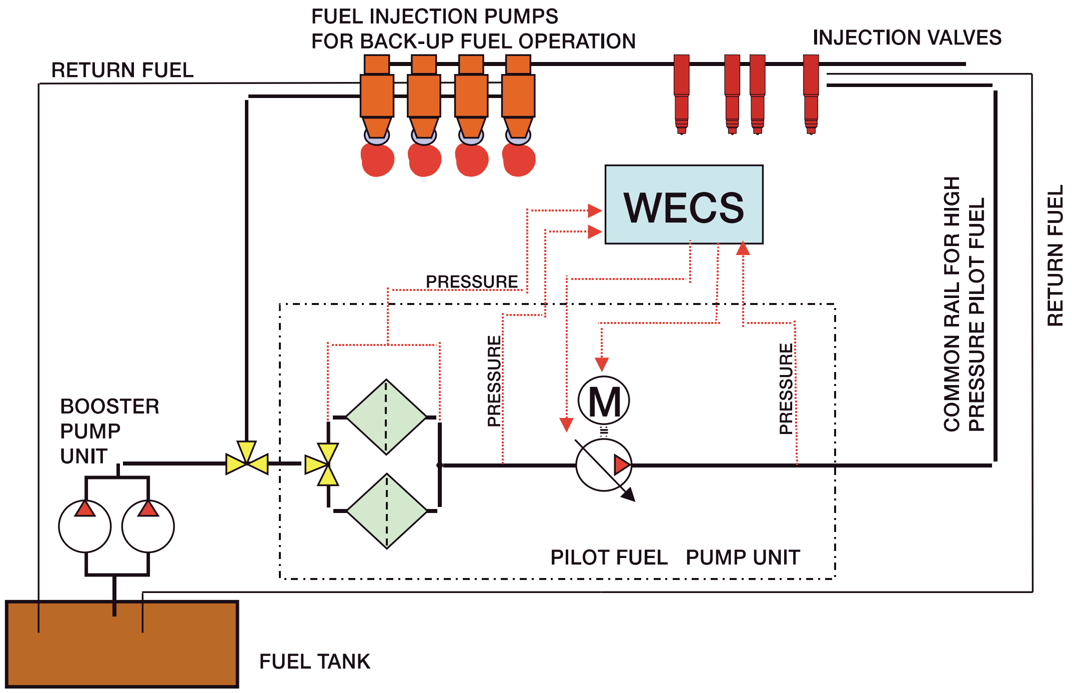
Filter is placed before every gas admission valve, preventing particles from entering the valve.



Diesel Oil Supply System

On the engine, the fuel oil is divided into two separate systems, one for full load LFO operation and one for the pilot fuel system for gas operation. The pilot fuel is first fed to a pump unit, including duplex filters, pressure regulator and the electronically driven radial piston-type pilot pump. The pilot pump raises the pilot fuel pressure to appr. 1000 bar. The fuel is then distributed through a common pipe system to the injection valves in the cylinder heads. Timing and duration of the pilot fuel injection are electronically controlled.

The backup fuel is fed to a normal camshaft-driver injection pump. From the injection pump the high-pressure fuel goes to a spring-loaded injection valve of standard diesel engine design.



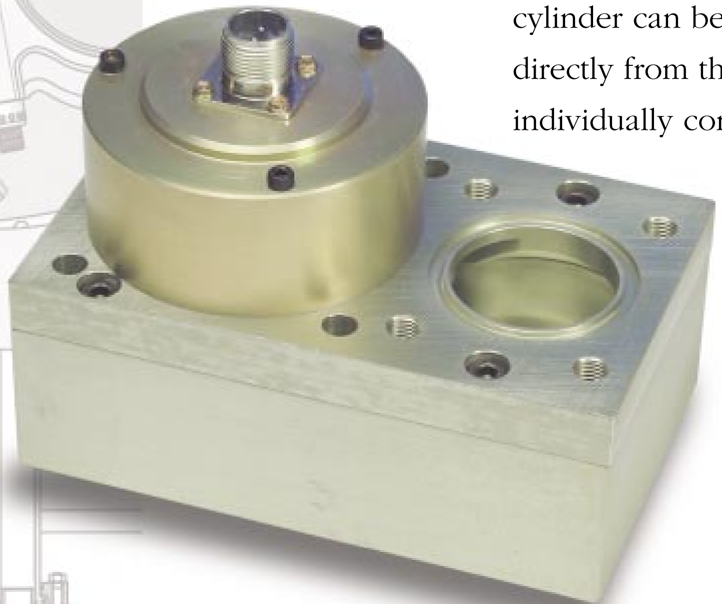
Injection valve

The Wärtsilä 32DF has a twin-needle injection valve. The larger needle is used in fuel oil mode and the smaller for pilot fuel oil when the engine is running in gas mode. Pilot injection is electronically controlled and the main diesel injection is hydromechanically controlled. The individually controlled solenoid valve allows optimum timing and duration of the pilot fuel injection for every cylinder when the engine is running in gas mode.

This leads to very low NO_x formation, while still employing a stable and reliable ignition source for the lean air-gas mixture in the combustion chamber, because NO_x formation is greatly dependent on the pilot fuel amount.

Gas admission valve

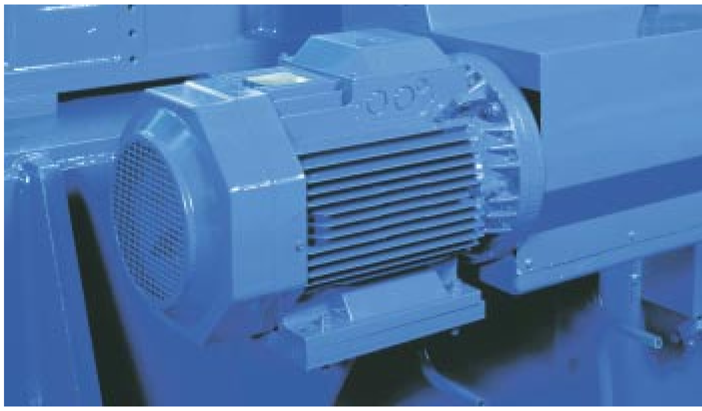
The Wärtsilä 32DF engine is equipped with a system that gives full control of the combustion process in each cylinder. The gas admission valves, located immediately upstream of the air inlet valves, are electronically actuated and controlled to give the correct amount of gas feed to each cylinder. Since the gas valve is timed independently of the inlet valve, the cylinder can be scavenged without risk of the gas escaping directly from the inlet to the exhaust. When the gas feed is individually controlled and adjusted under operation, every cylinder runs with the correct air-fuel ratio for the optimal operating point in terms of efficiency and emission. It also ensures reliable performance without shut-downs, knocking or misfiring.



Injection pump

Wärtsilä has developed a monoblock injection pump to withstand the high pressures involved in fuel injection. The pump is equipped with a constant-pressure relief valve system that makes it possible to avoid cavitation. The fuel injection nozzle has rounded inner edges at the nozzle holes that counteract the erosion and cavitation phenomena seen in conventional nozzles. The plunger is equipped with a wear-resistant coating.

Pilot pump

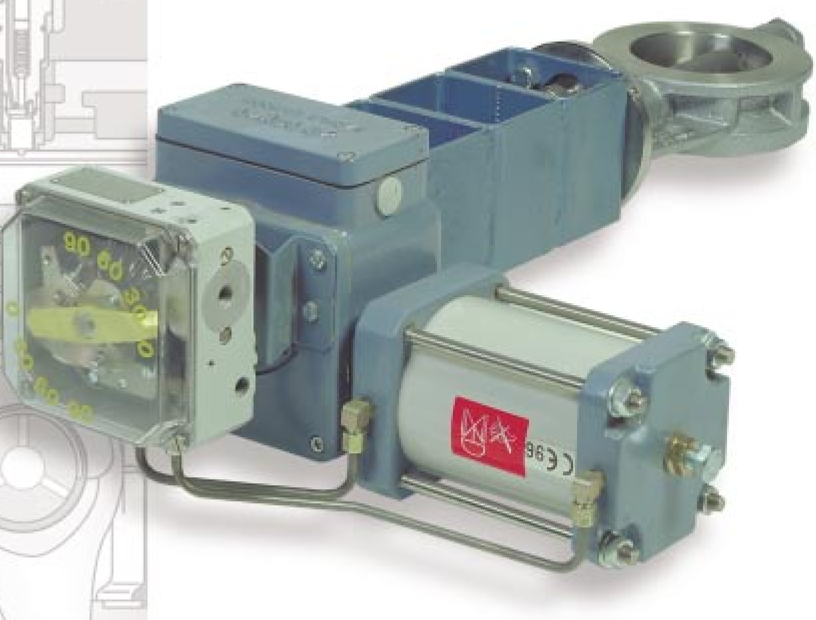


The pump unit consists of a radial piston pump, electric motor, fuel filters and the necessary valves and control system. The pump unit is a stand-alone device that receives start/stop and pressure signals from the engine control system and transmits the pressure level to it. The pilot fuel pressure is set to the required level by the engine control system. A common rail pipe delivers pilot fuel to each injection valve and acts as a pressure regulator against pressure pulses.

Fuel transfer

If a gas shutdown occurs due to e.g. interruption of the gas supply, the engine is automatically and instantly switched over to fuel oil operation. When the situation has turned back to normal the operator can transfer the engine back from back-up fuel to gas operation. This is possible at engine loads up to 80 %. This is a controlled transfer, decreasing fuel oil and increasing gas over a specified time of appr. 60 seconds.

Air – Fuel ratio control



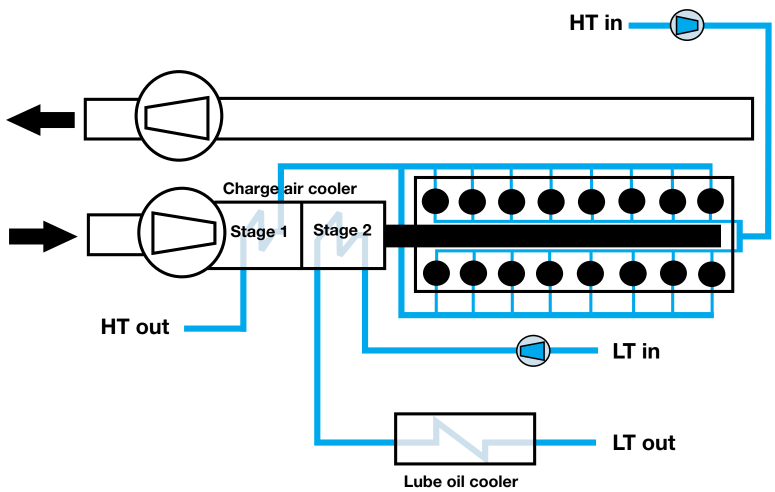
To always ensure optimum performance of the engine, it is essential to have the correct air-fuel ratio under all types of conditions. The Wärtsilä 32DF uses an exhaust-gas waste-gate valve to adjust the air-fuel ratio.

The exhaust-gas waste-gate, by-passes a part of the exhaust gases through the turbocharger. This valve adjusts the air-fuel ratio to the correct value regardless of varying site conditions under any engine loads.

Cooling system

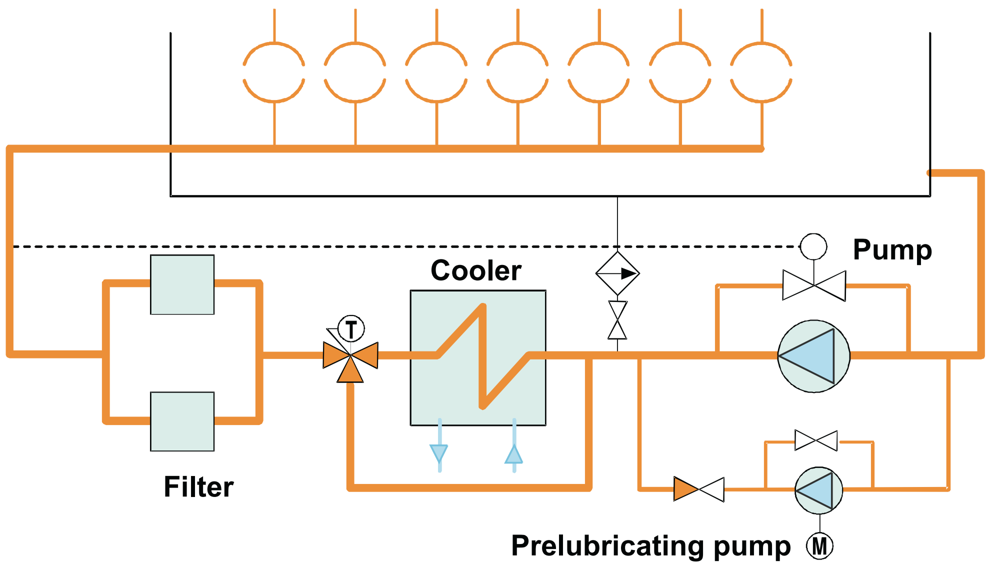
The cooling system is split into two separate circuits, the high-temperature (HT) and the low-temperature (LT) circuit. The cylinder liner and the cylinder head temperatures are controlled through the HT circuit. The HT circuit is also connected to the HT part of the double-stage charge air cooler.

The LT circuit serves the LT part of the charge air cooler and the lube oil cooler. Both HT and LT water pumps are engine driven as standard.



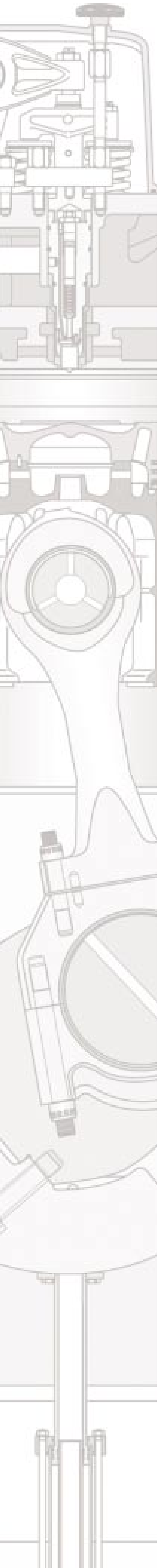
Lubricating oil system

The Wärtsilä 32DF is equipped with a wet oil sump, and the oil pump is engine driven. The oil is filtered through a full-flow paper cartridge filter. A centrifugal filter is mounted in bypass, acting as an indicator for excessive dirt in the lube oil. The engine uses a prelubricating system before starting to avoid wear of engine parts. For running in, provision has been made for mounting special running-in filters in front of each main bearing.



Starting system

The Wärtsilä 32DF engine is provided with turbine-type, pneumatic starting motors that cranks the engine through a gear ring on the flywheel. A pressure regulator adjusts the starting air pressure to its correct value. A starting limiter valve prevents the engine from starting if the turning gear is engaged.

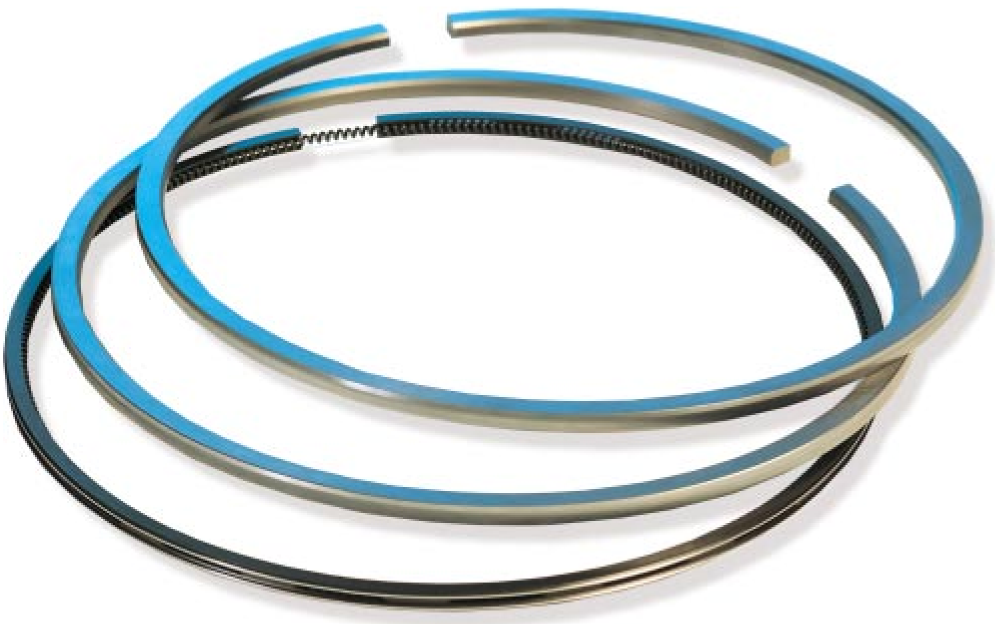


Piston

Pistons are of the low-friction, composite type with forged steel top and nodular cast iron skirt. The design itself is tailored for an engine of this size and includes a number of innovative approaches. Long lifetime is obtained through the use of Wärtsilä patented skirt-lubricating system, a piston crown cooled by ”cocktailshaker” cooling, induction hardened piston ring grooves and the piston ring low-friction concept.

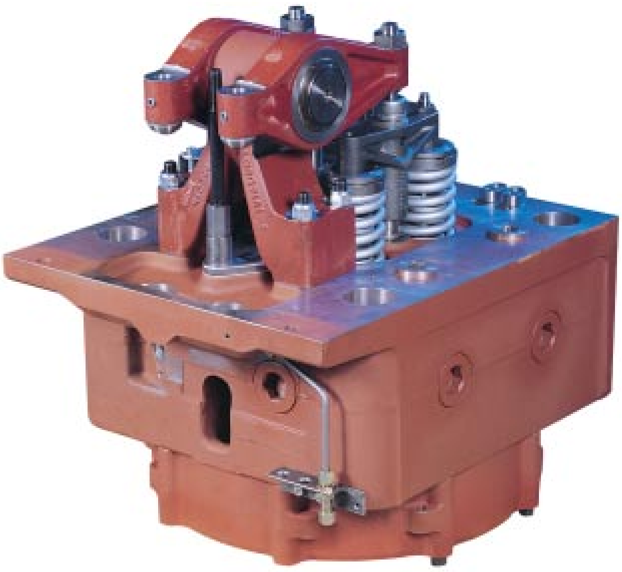
Piston ring set

The two compression rings and the oil control ring are located in the piston crown. This three-ring concept has proved its efficiency in all Wärtsilä engines. In a three-pack, every ring is dimensioned and profiled for the task it must perform. Most of the frictional loss in a reciprocating combustion engine originates from the piston rings. A three-ring pack is thus optimal with respect to both function and efficiency.



Cylinder head

Wärtsilä introduced four-screw cylinder head technology more than 20 years ago. At high cylinder pressure it has proved its superiority, especially when liner roundness and dynamic behaviour are considered. In addition to easier maintenance and reliability, it provides freedom in employing the most efficient air inlet and exhaust outlet channel configuration. A distributed water flow pattern is used for proper cooling of the exhaust valves, cylinder head flame plate and the twin needle injection valve. This minimizes thermal stress levels and guarantees a sufficiently low exhaust valve temperature. Both inlet and exhaust valves are fitted with rotators for even thermal and mechanical loading.

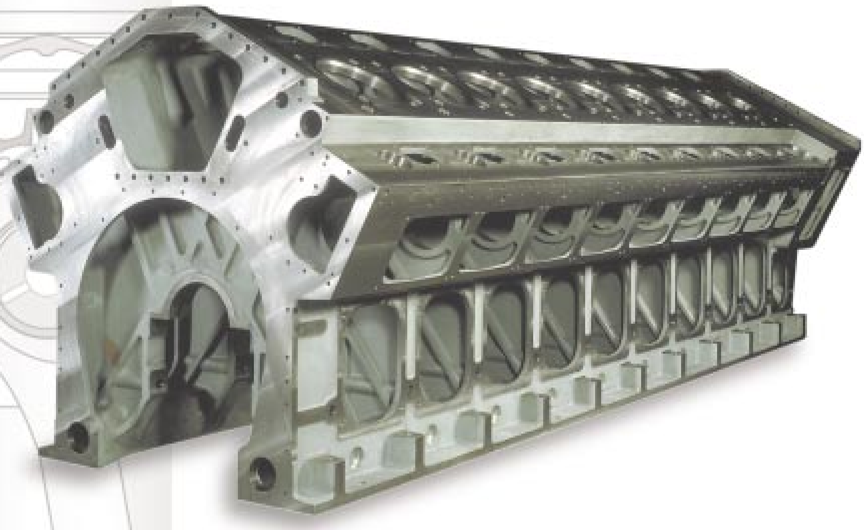


Connecting rod and big-end bearings

The connecting rod is designed for optimum bearing performance. It is a three-piece design, in which combustion forces are distributed over a maximum bearing area and relative movements between mating surfaces are minimized. Piston overhaul is possible without touching the big-end bearing and the big-end bearing can be inspected without removing the piston. The three-piece design also reduces the height of piston overhauling. The big-end bearing housing is hydraulically tightened, resulting in a distortion-free bore for the corrosion-resistant precision bearing.

Engine block

The engine block is cast in one piece with an integrated air receiver: it features high rigidity, simplicity and cleanliness. The engine has an underslung crankshaft, that imparts very high stiffness to the engine block, providing excellent conditions for main bearing performance. The engine block has large crankcase doors allowing easy maintenance.



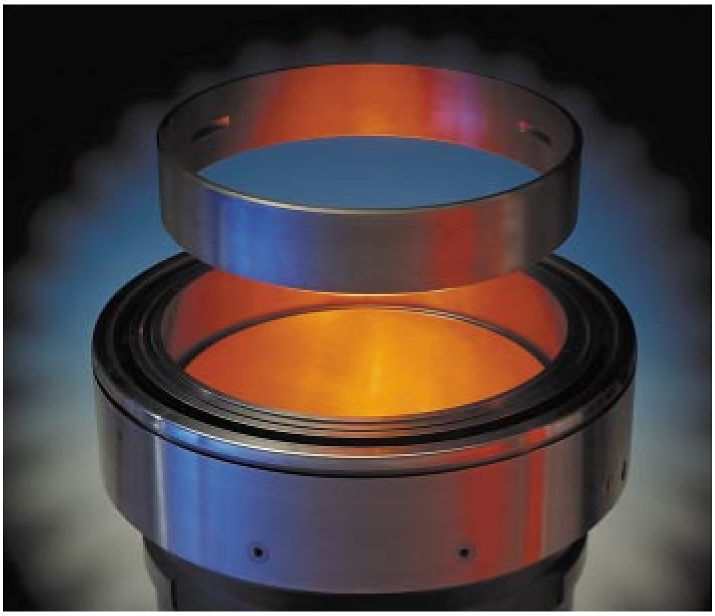
Crankshaft and bearings

The latest advance in combustion development requires a crank gear that can operate reliably at high cylinder pressures. The crankshaft must be robust and the specific bearing loads maintained at acceptable levels. Careful optimization of crank throw dimensions and fillets achieves this. The specific bearing loads are conservative, and the cylinder spacing, which is important for the overall length of the engine, is minimized. In addition to low bearing loads, the other crucial factor for safe bearing operation is oil film thickness.

Ample oil film thickness in the main bearings is ensured by optimal balancing of rotational masses, and in the big-end bearings by ungrooved bearing surfaces in the critical areas.

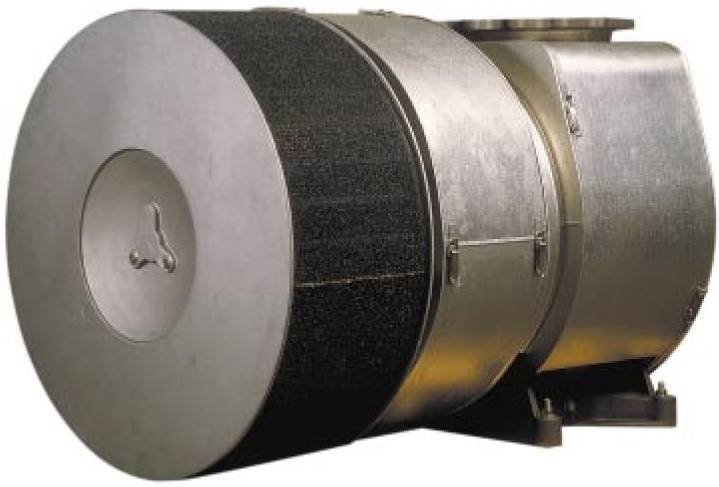
Cylinder liner and anti-polishing ring

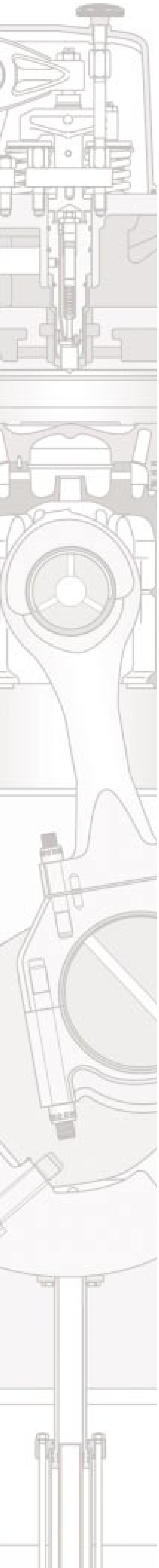
The cylinder liner and piston designs are based on extensive expertise in tribology and wear resistance acquired over many years of pioneering work in heavy-duty diesel engine design. The anti-polishing ring, which reduces lube oil consumption and wear, is an integral feature. The bore-cooled collar design of the liner ensures minimum deformation and efficient cooling. Each cylinder liner is equipped with two temperature sensors for continuous monitoring of piston and cylinder liner behaviour.



Turbocharging system

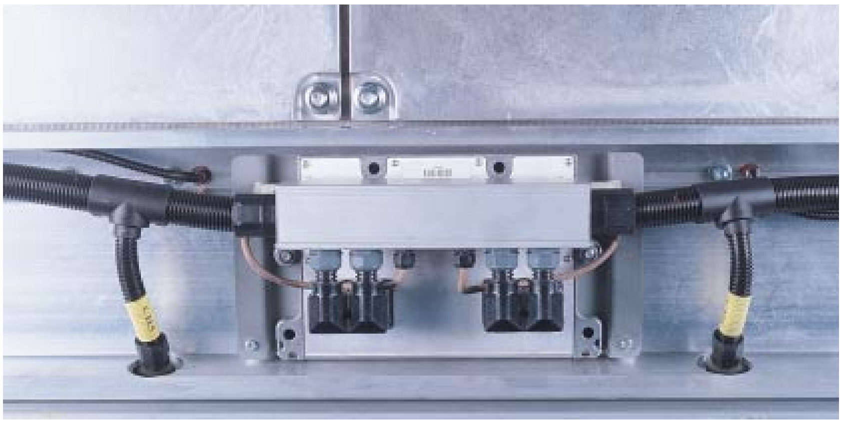
Every Wärtsilä 32DF is equipped with the Spex exhaust gas systems. The system is designed for minimum flow losses on both exhaust and air sides. The interface between engine and turbo- charger is streamlined with a minimum of flow resistance. The Wärtsilä 32DF engine uses high efficiency turbochargers with inboard plain bearings, and the engine lube oil system is also used for the turbocharger.





Automation system

The Wärtsilä engine control system (WECS) is an engine mounted distributed system. The various WECS modules are dedicated to different functions and communicate with each other via a databus. All parameters handled by the WECS can be transferred to the operator interface on the external control system.



- Easy maintenance and high reliability due to rugged engine dedicated connectors and prefabricated cable harness
- Less cabling on and around the engine
- Easy interfacing with external system via a databus
- Digitalized signals - immune from electromagnetic disturbance
- Built-in diagnosis for easy trouble-shooting

Main control module

The main control module is the master of the WECS system. The main control module reads the information sent by all the other modules. Based on the information it handles the speed and load control by determining reference values for the main and prechamber gas admission.

To obtain the best performance and reliable operation in different conditions, such as varying ambient temperature and methane number. The main control module is using the information sent from the different distributed modules to control the global air-fuel ratio as well as the global injection timing.

The main control module automatically controls the start and stop sequences of the engine and the safety system. The main control module also communicates with the external control system (PLC).

Cylinder control module

Each cylinder control module monitors and controls three cylinders. The cylinder control module controls the cylinder specific air-fuel ratio by adjusting the gas admission individually for all cylinders. This ensures the optimal combustion in all cylinders.

The cylinder control module measures the knock intensity i.e. uncontrolled combustion in all cylinders. The information of knock intensity is used to adjust the cylinder specific injection timing by the cylinder control module.

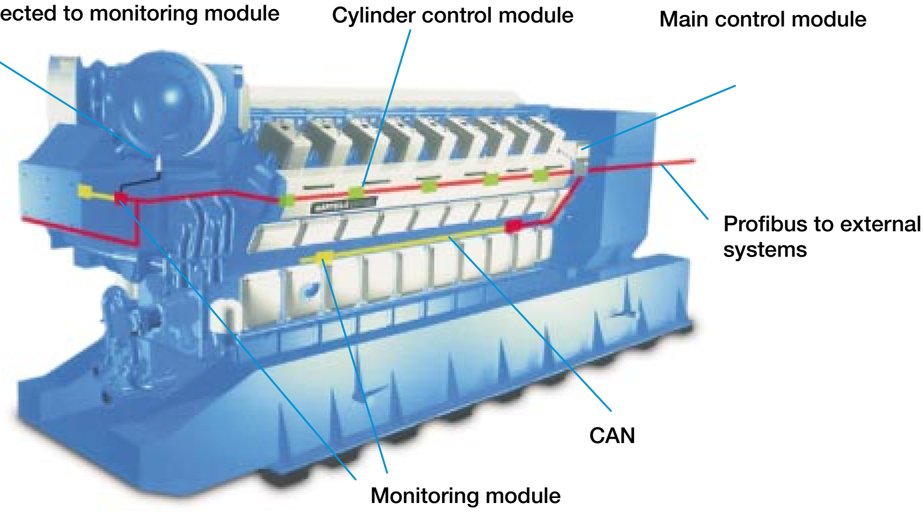
The cylinder control module also monitors the exhaust gas and cylinder liner temperatures of all cylinders.

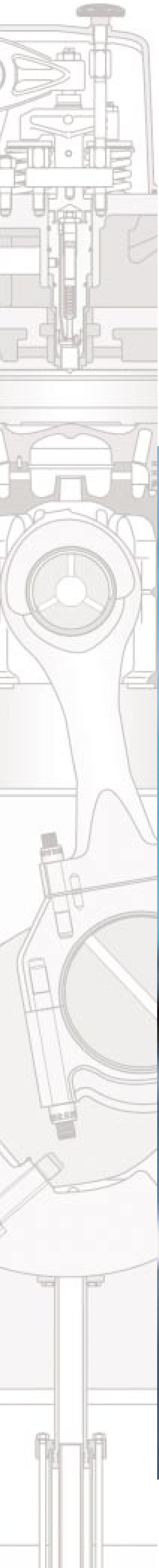
Light knocking leads to automatic adjustment of the injection timing as well as the air-fuel ratio.

Heavy knocking leads to gas shut-down and the engine continues to run in diesel operation.

Monitoring modules

Several monitoring modules are located close to groups of sensors, which shortens the cable harness on the engine. The monitored signals are transmitted to the main control module and used for the engine control or safety system. The monitored values are also transferred to the operator interface on the external control system.



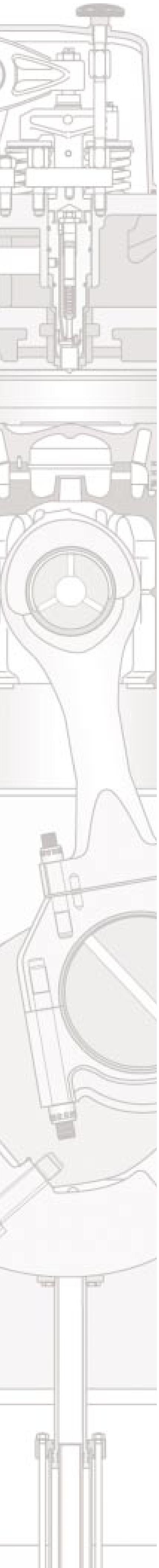


Easy maintenance

Thanks to the purity of the gas, the service life of Wärtsilä 32DF engine components and the time between overhauls are very long. For ease of maintenance, the engine block has large openings to the crankcase and camshaft. All bolts requiring high tension are hydraulically tightened. Hydraulics are extensively used for many other operations as well.

Since the main bearing caps are relatively heavy, each bearing cap is equipped with a permanently fitted hydraulic jack for easy manoeuvring of the cap. During delivery test runs, a running-in filter is installed to prevent the bearings from being scratched by any particles left in the piping system.

- A resiliently mounted insulating box surrounds the exhaust system. Easy access to the piping system is obtained by removing the insulating panels.
- The camshaft is built of identical cylinder segments bolted to intermediate bearing pieces.
- A wide range of special tools and measuring equipment specifically designed to facilitate service work are also available.
- Access to and maintenance of the pilot pump is easy. The pilot pump is located outside the engine.
- Use of electrically controlled gas admission valves means few mechanical parts and no need for periodic adjustments.
- The three-piece connecting rod allows inspection of the big-end bearing without removal of the piston, and piston overhaul without dismantling the big-end bearing.



Main Technical Data

Cylinder bore	320 mm
Piston stroke	350 mm
Speed range	720 and 750 rpm
Mean piston speed	8.4 / 8.75 m/s
BMEP	20 bar
Cylinder output	335 / 350 kW
Firing pressure	150 bar
Cylinder configuration	4, 6, 8 and 9 in-line
Cylinder configuration	12, 16 and 18 V

Gas operation:

Rated power: Base load generating sets

Engine type	720 rpm / 60 Hz		750 rpm / 50 Hz		Electrical efficiency %	
	*kWe	kWm	*kWe	kWm	TA-luft	½ TA-luft
4L32DF	1 290	1 340	1 350	1400	42.0	40.7
6L32DF	1 940	2 010	2 030	2100	42.0	40.7
8L32DF	2 590	2 680	2 700	2800	42.0	40.7
9L32DF	2 910	3 015	3 040	3150	42.0	40.7
12V32DF	3 880	4 020	4 050	4200	42.0	40.7
16V32DF	5 170	5 360	5 400	5600	42.0	40.7
18V32DF	5 820	6 030	6 100	6300	42.0	40.7

*Measured at generator terminals, ISO 3046 conditions and tolerances ±0%.
Generator efficiency 97% and NO_X=500 mg/m^3_N and 250 mg/m^3_N. Pilot fuel amount ≤ 1% on full load.

Back-up fuel operation:

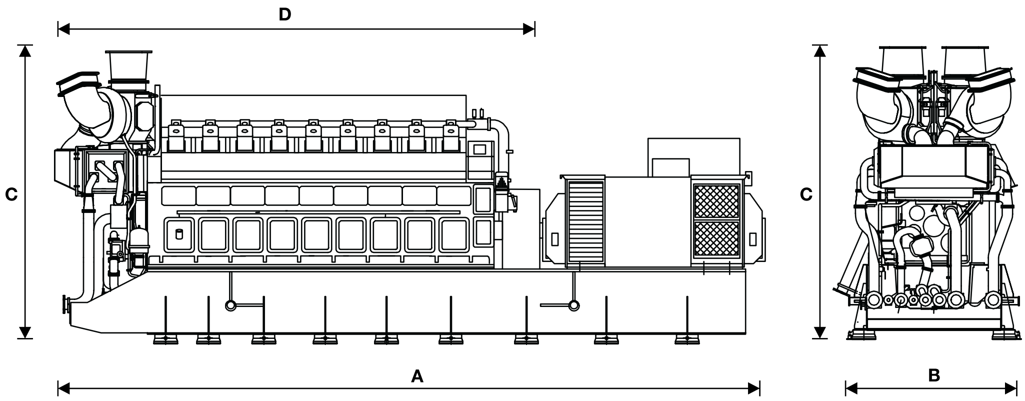
Rated power: Base load generating sets

Engine type	720 rpm / 60 Hz			750 rpm / 50 Hz		
	*kWe	kWm	Efficiency %	*kWe	kWm	Efficiency %
4L32DF	1 290	1 340	40.9	1 350	1 400	40.5
6L32DF	1 940	2 010	40.9	2 030	2 100	40.5
8L32DF	2 590	2 680	40.9	2 700	2 800	40.5
9L32DF	2 910	3 015	40.9	3 040	3 150	40.5
12V32DF	3 880	4 020	40.9	4 050	4 200	40.5
16V32DF	5 170	5 360	40.9	5 400	5 600	40.5
18V32DF	5 820	6 030	40.9	6 100	6 300	40.5

*Measured at generator terminals, ISO 3046 conditions and tolerances ±0%.
Generator efficiency 97%.

Principal genset dimensions (mm) and weights (tonnes)

Engine type	A	B	C	D	Weight
4L32DF	6 810	2 160	3 679	–	34
6L32DF	8 140	2 160	3 765	5 110	45
8L32DF	9 660	2 310	4 332	6 405	63
9L32DF	10 380	2 920	4 269	6 895	70
12V32DF	9 740	2 890	4 203	6 868	82
16V32DF	10 470	2 890	4 465	8 206	92
18V32DF	11 680	2 890	4 495	8 766	100



Gas fuel and diesel oil quality

The Wärtsilä 32DF can cope with most available natural gas qualities. Nominal design point is a methane number of 80. The engine can be operated on gases with lower methane numbers with a different performance. The Wärtsilä 32DF is designed and developed for continuous operation, without reduction in the rated output, on gas qualities according to following specification:

The gas engine Wärtsilä 32DF is designed and developed for continuous operation, without reduction in the rated output, on pilot and back-up fuels with the following properties:

Lower heating value (LHVV)	MJ/m^3_N	> 24
Methane number for nominal output		> 80
Methane content, CH_4	vol.-%	> 70
Hydrogen sulphide, H_2S	vol.-%	< 0.05
Hydrogen, H_2	vol.-%	< 3
Condense	vol.-%	0
Oil content	mg/m^3_N	< 5
Ammonia	mg/m^3_N	< 25
Chlorine + fluorines	mg/m^3_N	< 50
Particles or solids content	mg/m^3_N	< 50
Particles or solids size	μm	< 5
Gas inlet temperature	°C	0-50
Gas inlet pressure	bar (g)	3.5

Viscosity	cSt/40°C	< 11.0
Density at 15°C	g/ml	< 0.900
Water	% volume	< 0.3
Sulphur content	% mass	< 2.0
Ash content	% mass	< 0.01
Vanadium content	mg/kg	–
Sodium content	mg/kg	–
Conradson carbon residue	% mass	< 0.3
Asphaltenes	% mass	–
Flash point, PMCC	°C	> 60
Pour point	°C	≤ 6
Sediment	% mass	< 0.07
Cetane number		> 35

Wärtsilä Corporation is the leading global ship power supplier and a major provider of solutions for decentralized power generation and of supporting services.

In addition Wärtsilä operates a Nordic engineering steel company and manages substantial share holdings to support the development of its core business.

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WÄRTSILÄ

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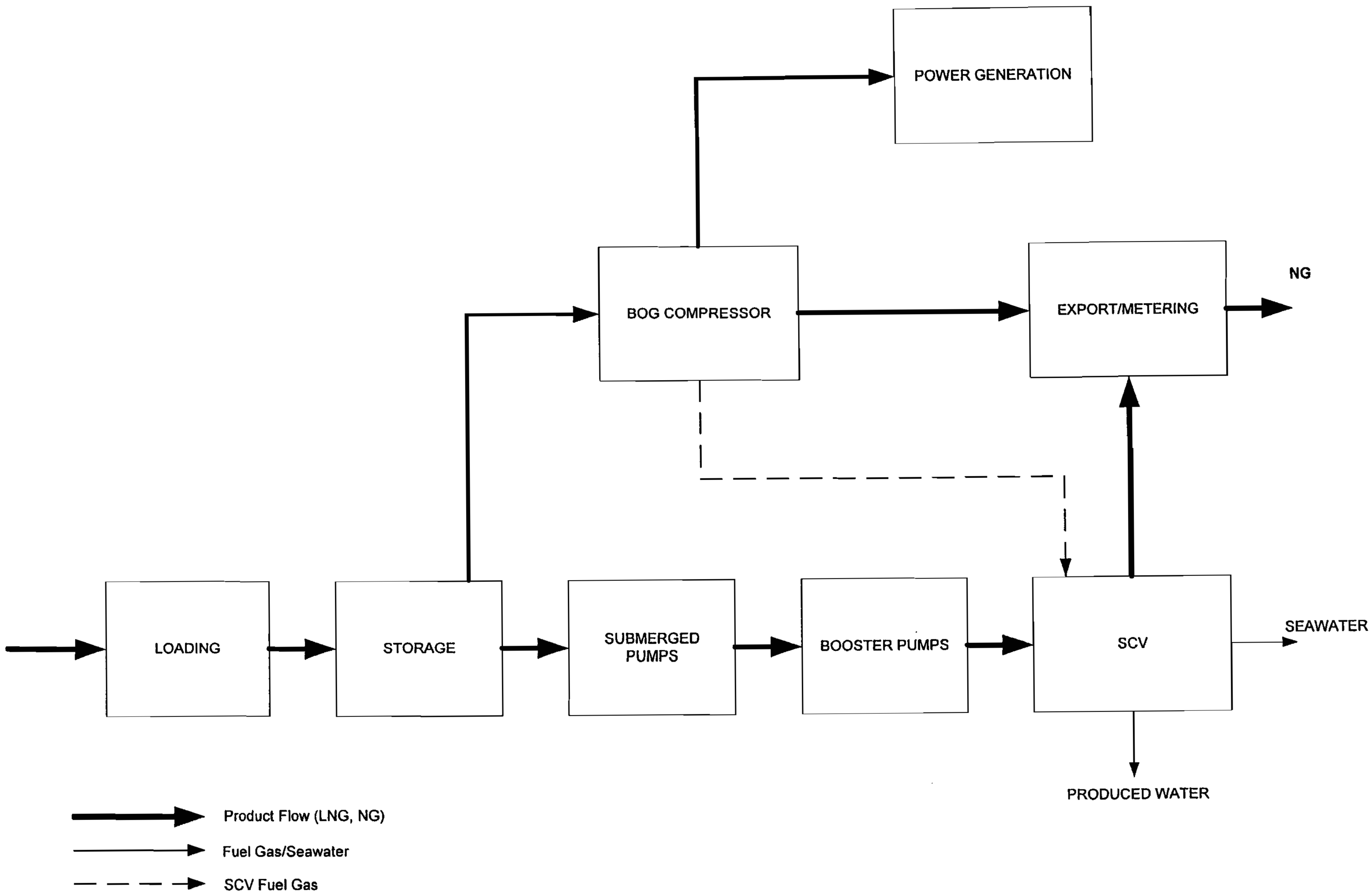
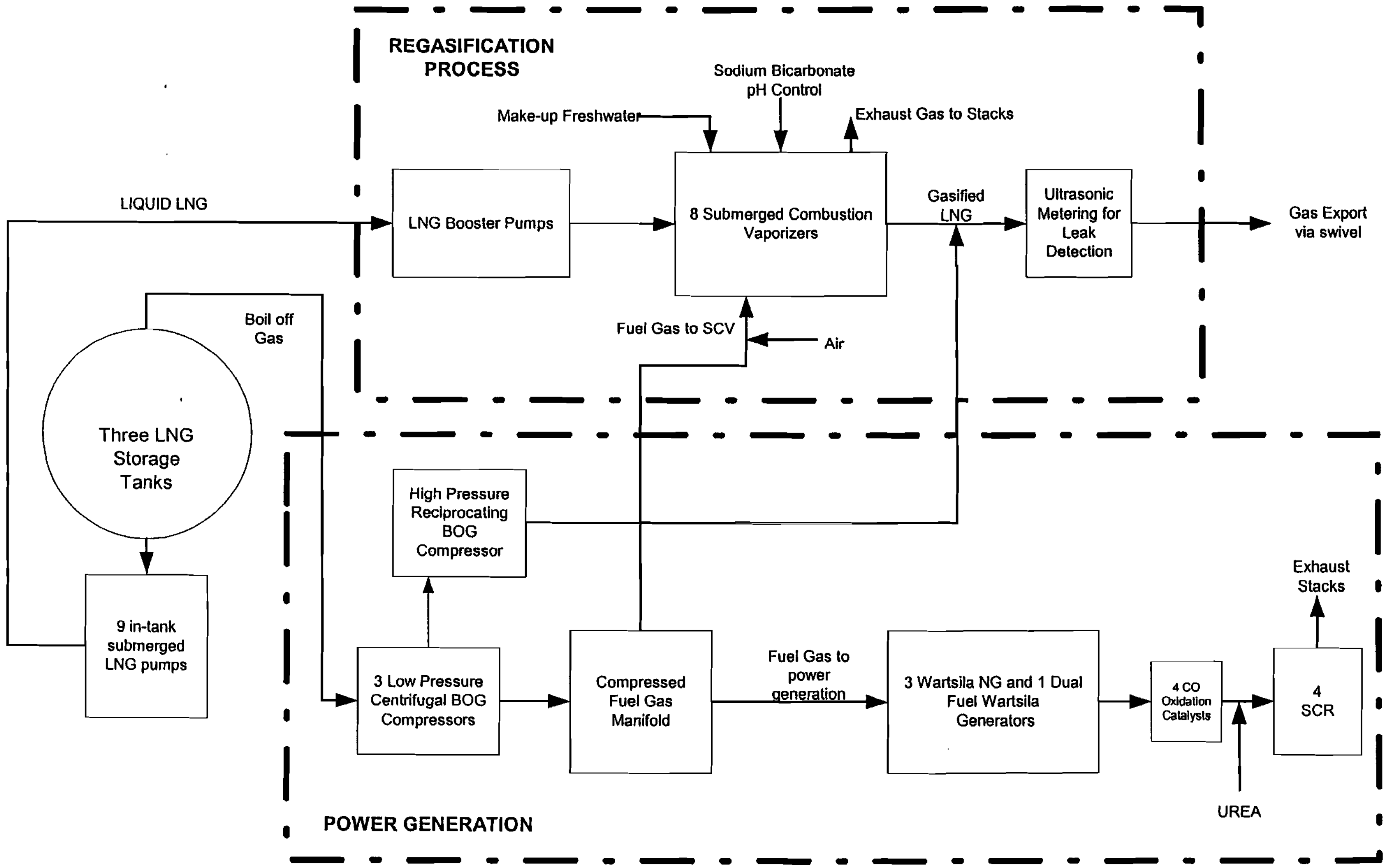
APPENDIX C
PROCESS FLOW DIAGRAMS

Simplified Proc‹ ›s Flow Diagram



Simplified Proc) Flow Diagram



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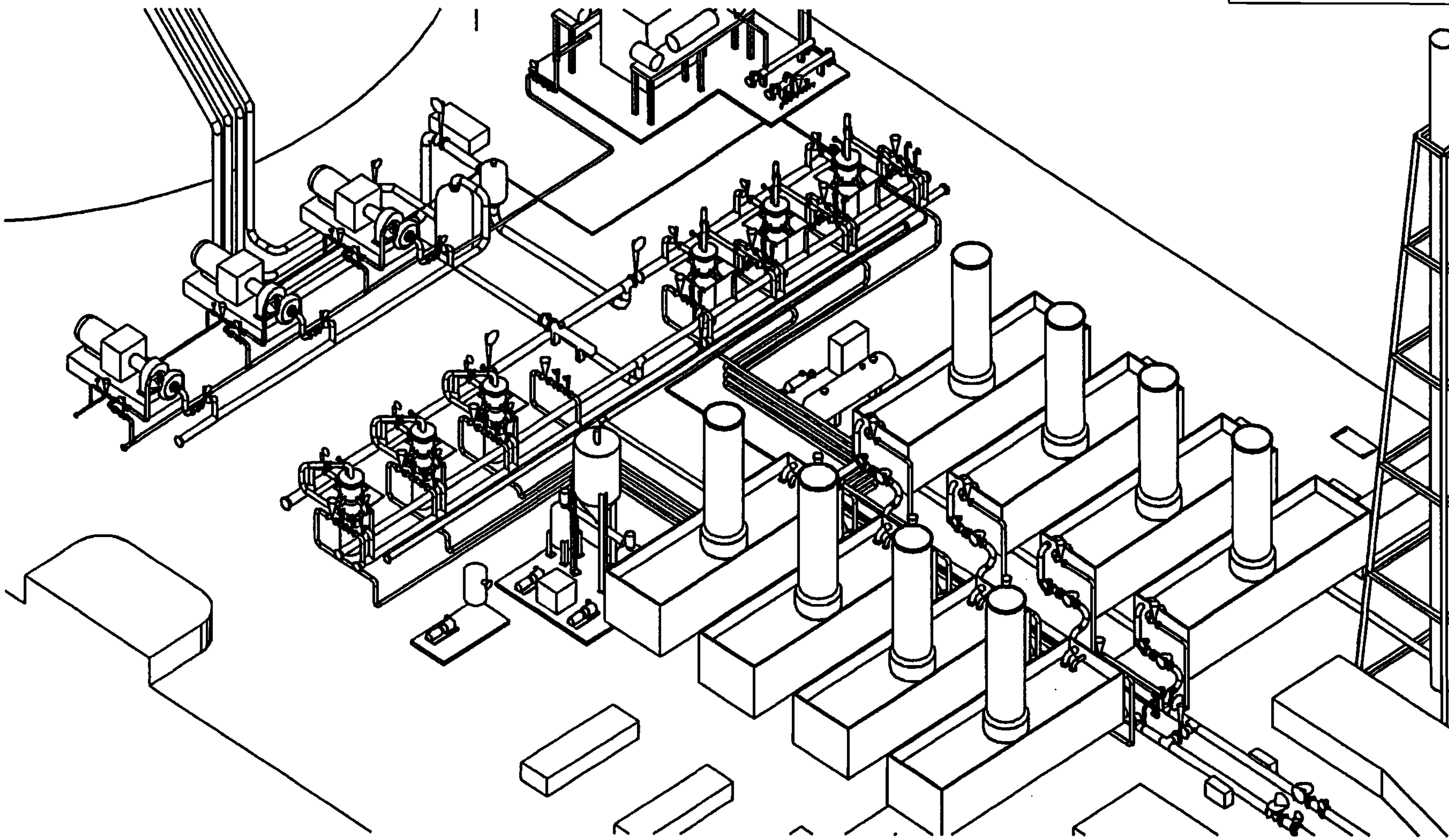

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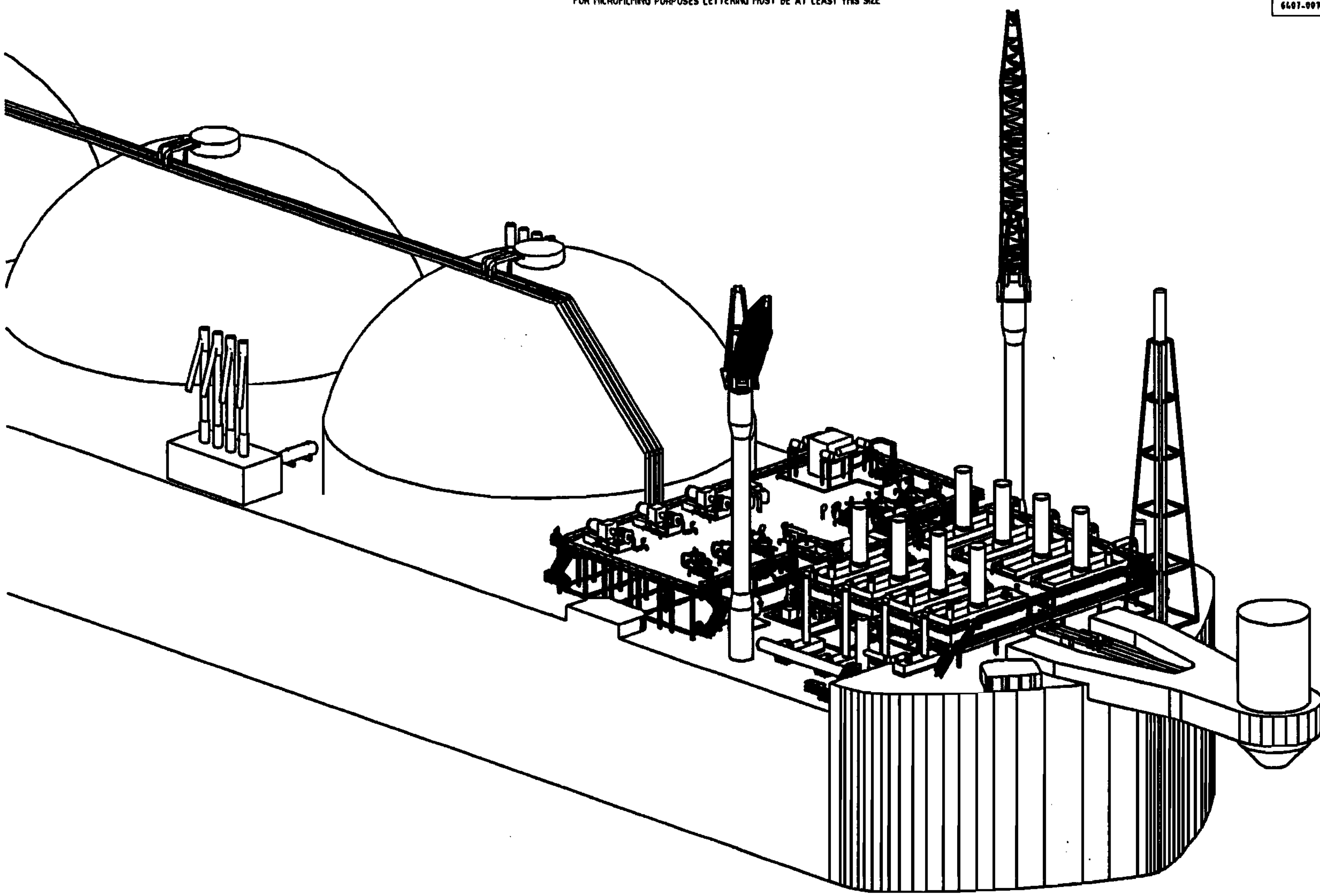

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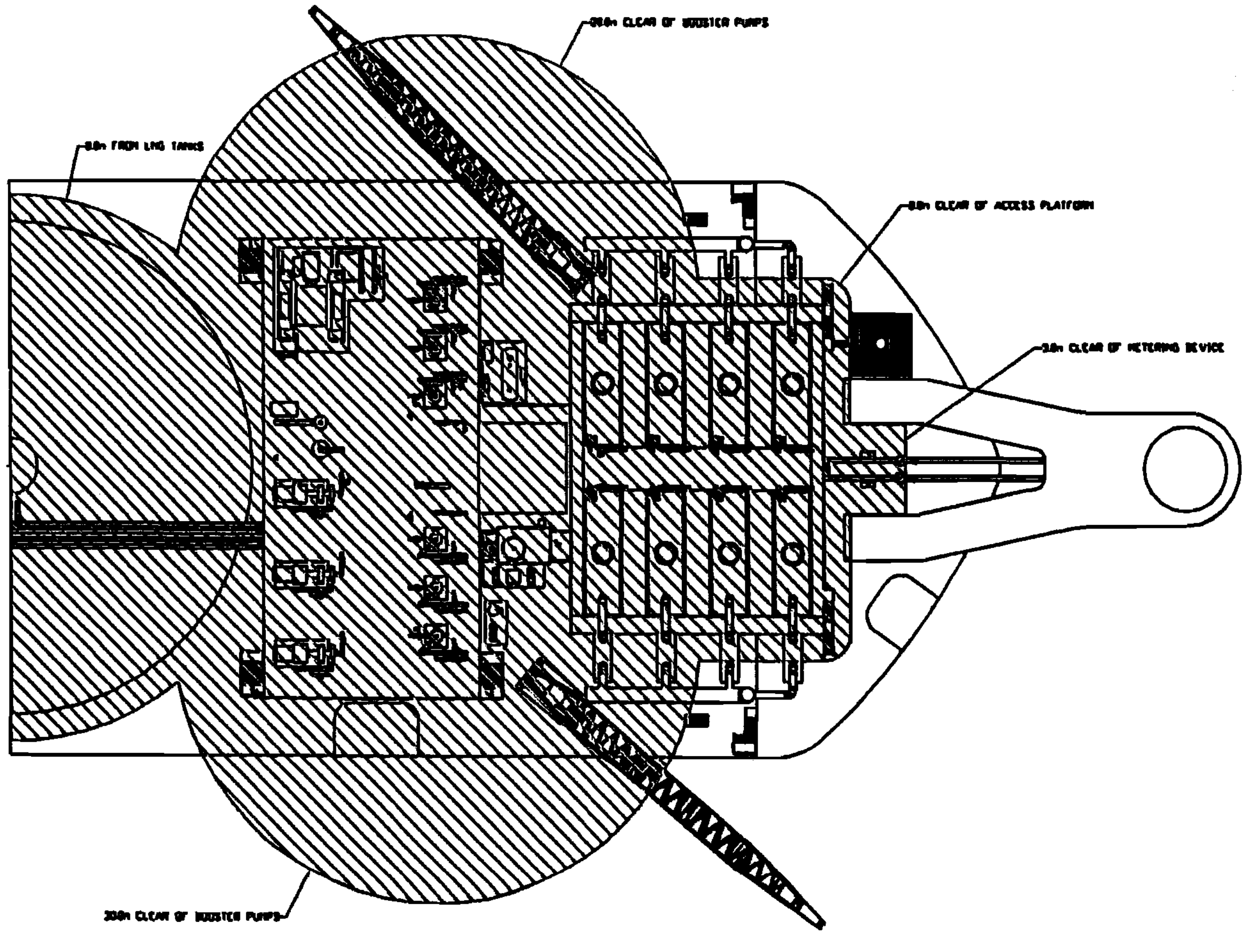

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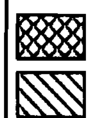
NOTES

1. HAZARDOUS AREA BASED ON API500:1997

2. EXTENT OF ALL HAZARDOUS AREAS TO BE CONFIRMED DURING DETAIL DESIGN

AREA CLASSIFICATION CODE API500:1997



GAS GROUP D (API500:1997)

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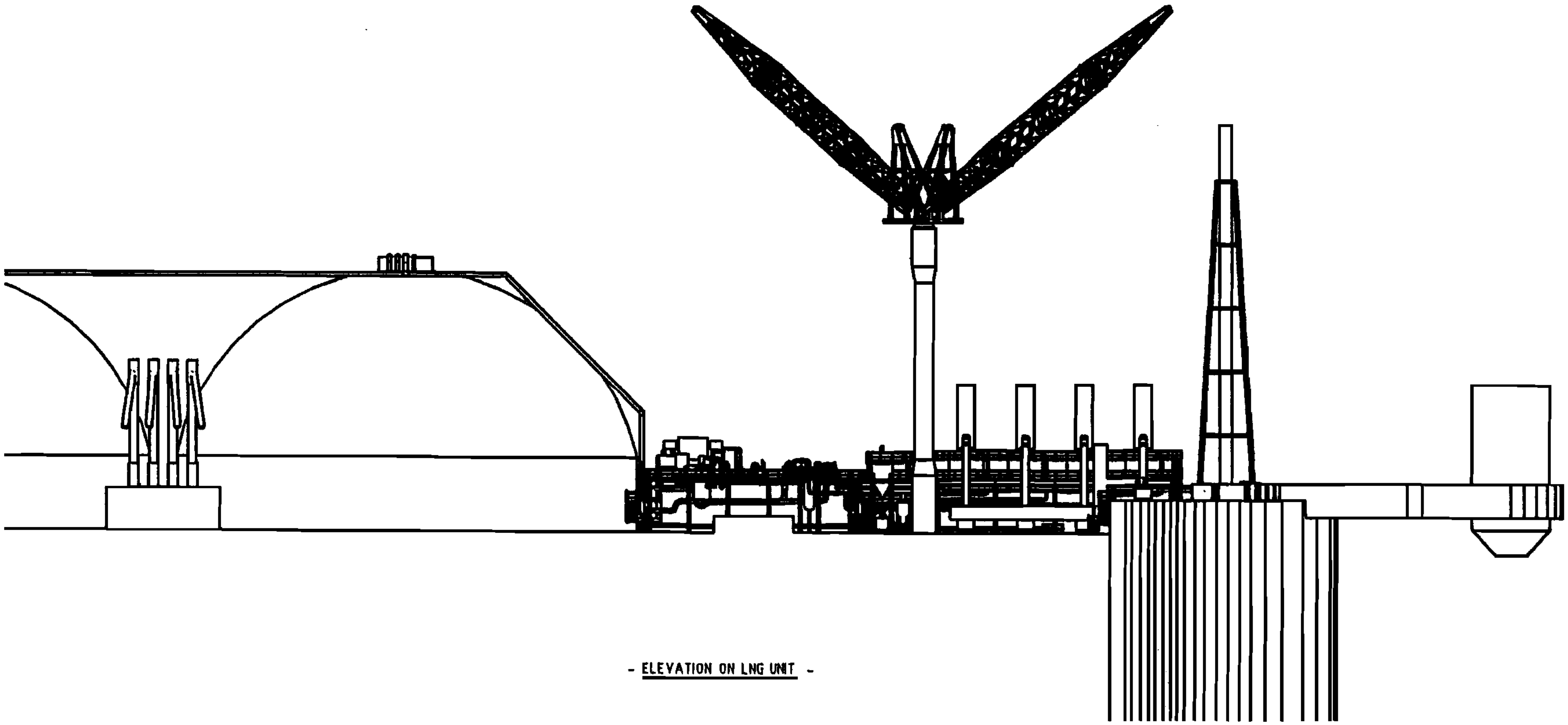

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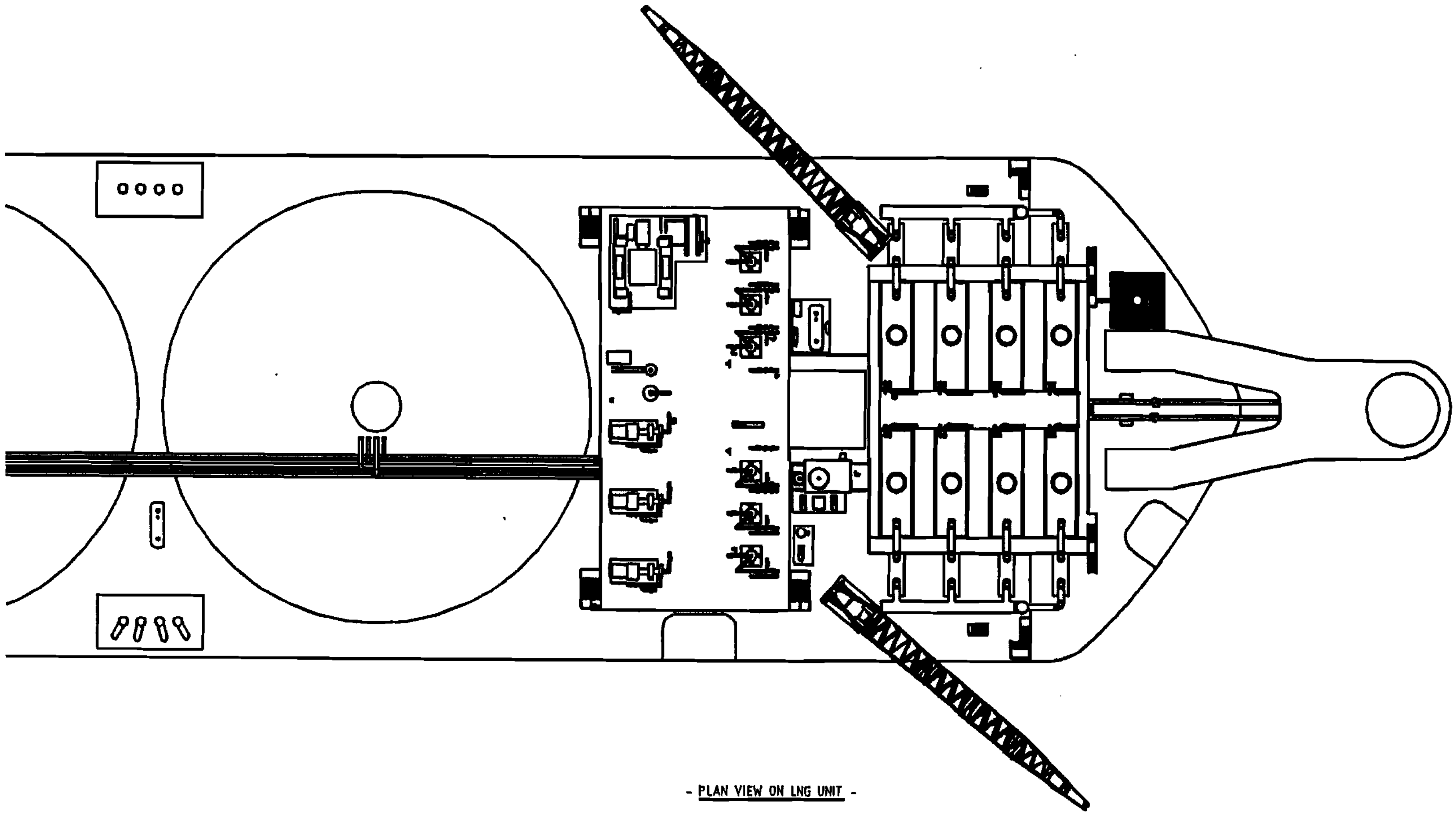

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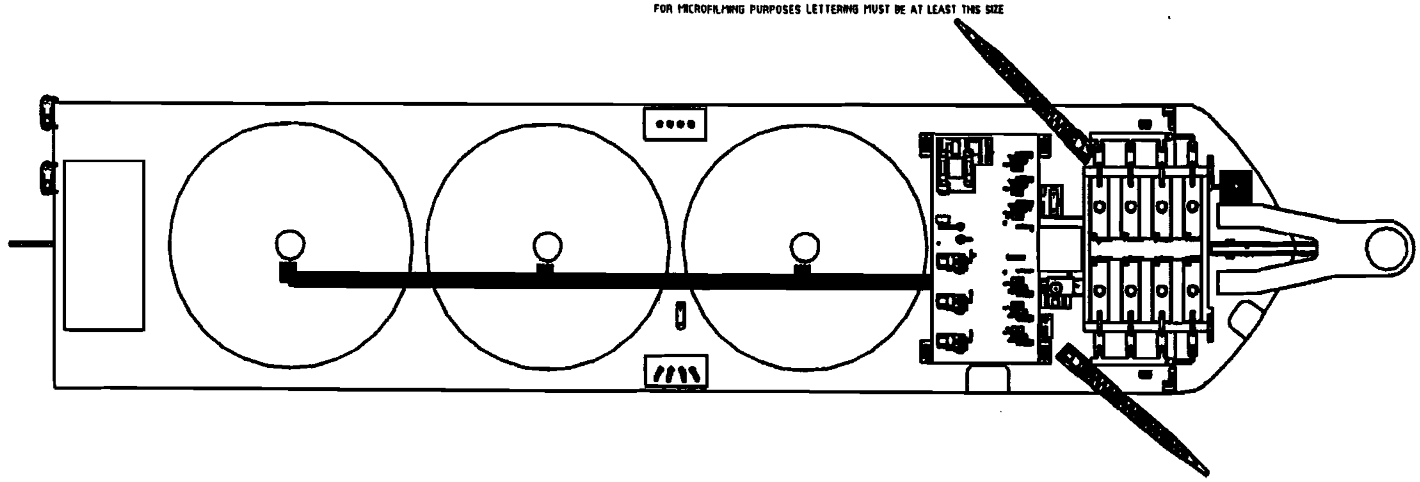

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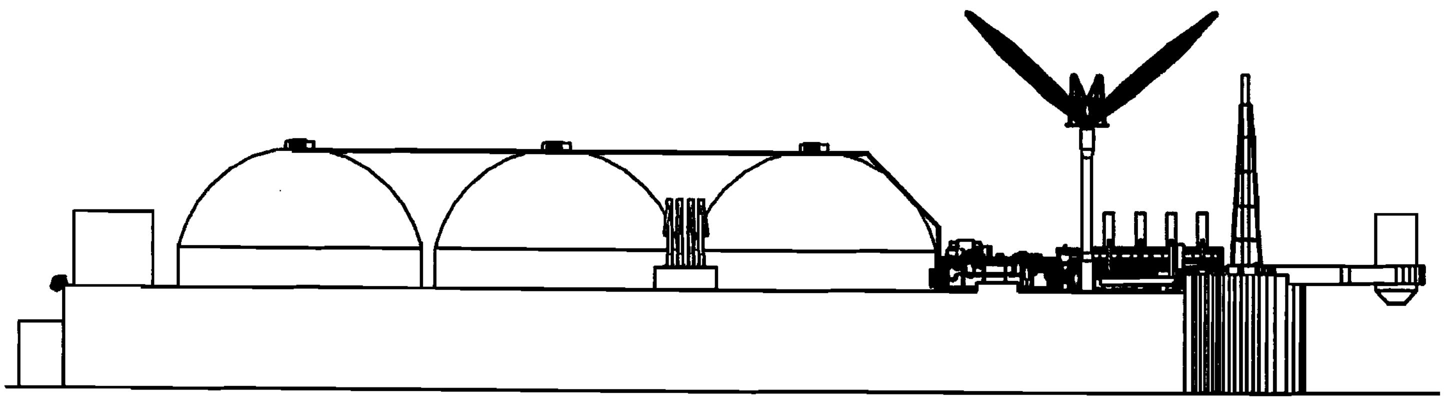

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APPENDIX D

CONTROL TECHNOLOGY CLEARINGHOUSE REFERENCES

ICE BACT Summary

Location	Ref.	Type	Rating	Units	NO_x	ROC	CO	PM10	Application	Controls
CA	S-3412-7-0	D2	310	g/BHP-hr	7.2	0.47	1.2	0.22	Emergency Fire Pump	
CA	F24215	D2	2155	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	363918	D2	883	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	364327	D2	1480	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	365785	D2	890	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	366370	D2	1109	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	359675	D2	100	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	360224	D2	86	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	359619	D2	480	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	356816	D2	68	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
CA	359076	D2	325	g/BHP-hr	6.9	1	8.5	0.38	Emergency Generator	
				g/kw-hr	9.25	1.34	11.40	0.51		
CA	S-416-5-0	D2	402	g/BHP-hr	7.2	1.1	3	1	Emergency Generator	
CA	N-3531-1-0		208	g/BHP-hr	6.63	0.33		0.25	Emergency Generator	
CA	189118	D2	2340	g/BHP-hr	1.5		2.6	0.15	Emergency Generator	1-way cat
				g/kw-hr	2.0					
CA	360419	Nat Gas	1334	g/BHP-hr	1.5	1.5	2		Standby Generator	3-way cat, A/F cntl
CA	362406	Nat Gas	171	g/BHP-hr	0.15	0.15	0.6		Chiller Drives	3-way cat, A/F cntl
CA	361525	Nat Gas	93	g/BHP-hr	0.15	0.15	0.6		Standby Generator	3-way cat, A/F cntl
CA	359876	Nat Gas	750	g/BHP-hr	0.15	0.15	0.6		Flood Pump	3-way cat, A/F cntl
				g/kw-hr	0.20	0.20	0.80			
NJ	1-96-4371	Nat Gas	3130	g/BHP-hr	0.27	0.11	0.25		Pump	SCR/Oxcat
NJ	1-96-4371	Nat Gas	3130	g/BHP-hr	0.8	1	1.8		Pump	Lean Burn
CA	891221	Nat Gas	2400	g/BHP-hr	0.8				Wastewater Pumps	Lean Burn
CA	9975	Nat Gas	116	g/BHP-hr	0.15	0.3	0.75		Compressor Drive	3-way cat, A/F cntl
CA	C-709-13-0	Nat Gas	145	g/BHP-hr	0.72	0.78	1.24		Standby Generator	Lean Burn
CA	C-2958-1-0	Nat Gas	365	g/BHP-hr	0.33	0.068	2		Standby Generator	3-way cat, A/F cntl
CA	7018-110	Nat Gas	130	g/BHP-hr	0.15	0.6			Chiller Drives	3-way cat, A/F cntl
CA	0294-120	Nat Gas	108	g/BHP-hr	0.15	0.20			Standby Generator	3-way cat, A/F cntl
CA	223469	Nat Gas	525	g/BHP-hr	1.5				Standby Pump	3-way cat, A/F cntl
CA	2066012	Nat Gas	525	g/BHP-hr	1				Compressor Drive	3-way cat, A/F cntl
CA	7815C, D	Nat Gas	251	g/BHP-hr	0.75				Standby Generator	Lean Burn
CA	0041-6	Nat Gas	225	g/BHP-hr	0.805				Compressor Drive	1-way cat
CA	1369-1	Nat Gas	195	g/BHP-hr	0.805				Compressor Drive	1-way cat

ICE BACT Summary

Location	Ref.	Type	Rating	Units	NO_X	ROC	CO	PM10	Application	Controls
CA	3043	Nat Gas	2133	g/BHP-hr	1				Generator	1-way cat
CA	2028022	Nat Gas	168	g/BHP-hr	1.09				Compressor Drive	1-way cat
CA	380	Nat Gas	200	g/BHP-hr	0.805				Compressor Drive	1-way cat
CA	951	Nat Gas	180	g/BHP-hr	1.26				Compressor Drive	1-way cat
CA	2023008	Nat Gas	2133	g/BHP-hr	1.5				Compressor Drive	1-way cat
CA	27796	Nat Gas	526	g/BHP-hr	0.48				Generator	1-way cat
CA	392542	D2	764	g/BHP-hr	5.02	0.03	0.26	0.023	Conformity Cert	meets EPA Tier 2
CA	392543	D2	685	g/BHP-hr	4.75	0.05	0.21	0.03	Conformity Cert	meets EPA Tier 2
CA	392544	D2	610	g/BHP-hr	4.52	0.06	0.17	0.03	Conformity Cert	meets EPA Tier 2
CA	392545	D2	536	g/BHP-hr	<4.8	<2.6	<0.15		Conformity Cert	EPA Tier 2 std
CA	392546	D2	471	g/BHP-hr	<4.8	<2.6	<0.15		Conformity Cert	EPA Tier 2 std
CA	390213	D2	470	g/BHP-hr	<4.8	<2.6	<0.15		Conformity Cert	EPA Tier 2 std
CA	390214	D2	395	g/BHP-hr	<4.8	<2.6	<0.15		Conformity Cert	EPA Tier 2 std
CA	393278	D2	295	g/BHP-hr	3.82	0.19	0.4	0.34	Standby Generator	meets EPA Tier 2
CA	392676	D2	267	g/BHP-hr	4.07	0.23	0.32	0.24	Standby Generator	meets EPA Tier 2
CA	395874	D2	300	g/BHP-hr	5.89	0.73	3.55	0.25	Fire Pump	meets 1998 BACT
CA	372882	D2	110	g/BHP-hr	6.9	1	8.5	0.38	Fire Pump	1998 BACT
CA	360419	Nat Gas	1334	g/BHP-hr	1.5	1.5	2		Standby Generator	3-way cat, A/F cntl
CA	F34242	Nat Gas	84	g/BHP-hr	0.103	0.02	0.34		Generator	3-way cat, A/F cntl
CA	362406	Nat Gas	171	g/BHP-hr	0.15	0.15	0.6		Chiller Drives	3-way cat, A/F cntl
VCAPCD			Rule 74.9	ppmv	25	250	4500			
SCAQMD			Rule 1110.2	ppmv	59	410	2000			

APPENDIX E
LEVEL 1 VISIBILITY ANALYSIS RESULTS

Visual Effects Screening Analysis for
Source: Cabrillo Port Vessel
Class I Area: San Rafael Wilderness

*** User-selected Screening Scenario Results ***

Input Emissions for

Particulates	.37	G	/S
NOx (as NO2)	2.05	G	/S
Primary NO2	.00	G	/S
Soot	.00	G	/S
Primary SO4	.00	G	/S

**** Default Particle Characteristics Assumed

Transport Scenario Specifications:

Background Ozone:	.07 ppm
Background Visual Range:	243.30 km
Source-Observer Distance:	102.50 km
Min. Source-Class I Distance:	102.50 km
Max. Source-Class I Distance:	157.50 km
Plume-Source-Observer Angle:	11.25 degrees
Stability:	6
Wind Speed:	1.00 m/s

R E S U L T S

Asterisks (*) indicate plume impacts that exceed screening criteria

Maximum Visual Impacts INSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	140.	137.0	29.	2.00	.108	.05	.001
SKY	140.	140.	137.0	29.	2.00	.033	.05	-.001
TERRAIN	10.	84.	102.5	84.	2.00	.129	.05	.001
TERRAIN	140.	84.	102.5	84.	2.00	.014	.05	.000

Maximum Visual Impacts OUTSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	0.	1.0	169.	8.03	2.456	.18	.028
SKY	140.	0.	1.0	169.	5.03	.593	.18	-.017
TERRAIN	10.	0.	1.0	169.	7.41	1.993	.18	.023
TERRAIN	140.	0.	1.0	169.	4.75	.634	.18	.015

Visual Effects Screening Analysis for
Source: Cabrillo Port Vessel
Class I Area: San Gabriel Wilderness

*** User-selected Screening Scenario Results ***

Input Emissions for

Particulates	.37	G	/S
NOx (as NO2)	2.05	G	/S
Primary NO2	.00	G	/S
Soot	.00	G	/S
Primary SO4	.00	G	/S

**** Default Particle Characteristics Assumed

Transport Scenario Specifications:

Background Ozone:	.07 ppm
Background Visual Range:	246.40 km
Source-Observer Distance:	107.80 km
Min. Source-Class I Distance:	107.80 km
Max. Source-Class I Distance:	123.90 km
Plume-Source-Observer Angle:	11.25 degrees
Stability:	6
Wind Speed:	1.00 m/s

R E S U L T S

Asterisks (*) indicate plume impacts that exceed screening criteria

Maximum Visual Impacts INSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	120.	123.9	49.	2.00	.094	.05	.001
SKY	140.	120.	123.9	49.	2.00	.039	.05	-.001
TERRAIN	10.	84.	107.8	84.	2.00	.119	.05	.001
TERRAIN	140.	84.	107.8	84.	2.00	.013	.05	.000

Maximum Visual Impacts OUTSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	5.	33.6	164.	2.00	.521	.05	.006
SKY	140.	5.	33.6	164.	2.00	.110	.05	-.004
TERRAIN	10.	5.	33.6	164.	2.00	.411	.05	.005
TERRAIN	140.	5.	33.6	164.	2.00	.091	.05	.002

Visual Effects Screening Analysis for
Source: Cabrillo Port Vessel
Class I Area: Cucamonga Wilderness

*** User-selected Screening Scenario Results ***

Input Emissions for

Particulates	.37	G /S
NOx (as NO2)	2.05	G /S
Primary NO2	.00	G /S
Soot	.00	G /S
Primary SO4	.00	G /S

**** Default Particle Characteristics Assumed

Transport Scenario Specifications:

Background Ozone:	.07 ppm
Background Visual Range:	246.40 km
Source-Observer Distance:	133.60 km
Min. Source-Class I Distance:	133.60 km
Max. Source-Class I Distance:	143.20 km
Plume-Source-Observer Angle:	11.25 degrees
Stability:	6
Wind Speed:	1.00 m/s

R E S U L T S

Asterisks (*) indicate plume impacts that exceed screening criteria

Maximum Visual Impacts INSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	84.	133.6	84.	2.00	.067	.05	.001
SKY	140.	84.	133.6	84.	2.00	.029	.05	-.001
TERRAIN	10.	84.	133.6	84.	2.00	.072	.05	.001
TERRAIN	140.	84.	133.6	84.	2.00	.008	.05	.000

Maximum Visual Impacts OUTSIDE Class I Area
Screening Criteria ARE NOT Exceeded

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance	Alpha	Crit	Plume	Crit	Plume
SKY	10.	5.	41.6	164.	2.00	.384	.05	.005
SKY	140.	5.	41.6	164.	2.00	.085	.05	-.003
TERRAIN	10.	5.	41.6	164.	2.00	.261	.05	.003
TERRAIN	140.	5.	41.6	164.	2.00	.072	.05	.002